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BLYDE RIVER AQUEDUCT, TRANSVAAL.

THE aqueduct carries water lifted from the river Blyde, a tributary of the river Oliphants, to the Transvaal Gold Exploration and Land Company's Battery at Brown's Hill, Pilgrims' Rest, Africa. The water runs in a ditch from the dam at the lift to the aqueduct, and from the outlet of the aqueduct the ditch is continued to the hill. The ditch is 5 ft. wide at the bottom and 10 ft. wide at the top, and averages in depth some 4 ft. 6 in. It has a grade of 7 ft. to the mile, and is 2½ miles long, exclusive of the length of the aqueduct. The aqueduct is 400 ft. long from head tank to tail tank, and is a cylindrical pipe 2 ft. 6 in. in diameter. The inlet end is 3 ft. in diameter, tapering to 2 ft. 6 in. in the first 10 ft. The pipe has a grade of 24½ in. in its length, and the total amount of head which can be applied if necessary is 5 ft., which would allow the pipe to pass 2,600 cubic feet of water per minute, or 23,400,000 gallons per twenty-four hours. The river Blyde, which has a large watershed, is capable of supplying this in the very driest part of the season. The inlet end of the aqueduct is fitted with a head tank and special bywash, with sluice gates and slides. The tail tank discharges the outflow into a water cushion built of solid limestone in cement. This cushion was deemed necessary to counteract the impact of the outflowing water, because the ditch at this point runs in exceedingly bad ground, which was only rendered tight after most laborious sodding up and puddling.

The cutting in the bank here is over 20 ft. deep in places, and on the very edge of the hill side. The pipe is built up of wrought iron plates ⅛ in. thick, riveted up in lengths of 18 ft. each. Such a pipe, 30 in. in diameter, will work under an 80 ft. head with safety. The pipe was made on the spot. The joints between the various lengths are made by drawing the top or larger end of one section about 3½ in. to 4 in. over the bottom or smaller end of the next above it. The sections of piping are constructed with a slight taper to meet this, and the joint is made tight by inserting tarred canvas between the inner and outer pipe before drawing up. Thus every joint is a flexible one, and on the consideration of the rest of the structure, allowances and calculations for expansion and contraction did not occupy much space. An idea of the structure itself can be gathered from our engravings reproduced from photographs. All the timber was cut in the adjacent cloofs and sawn on the spot. The span across the river is 75 ft. in length, and top of the pipe is 30 ft. above high flood. There is a passenger foot way 2 ft. wide from one end to the other, which makes this structure the first passenger bridge over 300 ft. long crossing a river in the Transvaal, and it is the largest pipe aqueduct in South Africa. With the exception of the span, all transverse and longitudinal bearers are 6 in. by 4 in. white African pear wood. The girders of the span are two main, each 12 in. by 6 in. pitch pine, made up of 12 in. by 3 in. planks braced and spliced, as may be seen in the engraving of the span.

With one smith, one sawyer, two carpenters, one mason, and one handyman, with twelve Kafirs, the structure was brought to its present condition in twelve weeks, and every bolt and angle in the structure was made on the spot, the drought having prevented the arrival of stores. The whole structure is tarred and pitched throughout; all bolt and spike holes were filled with pitch before the spikes or bolts were driven up. When the full pressure of water was turned down the pipe, the deflection of the span was not readable on the leveling staff. The water after leaving the aqueduct passes down the ditch to the battery. Just above the battery is an elaborate bywash fitted with sluice gates and slides, which is capable of turning all the water away from the battery in about fifteen seconds should occasion arise. At the battery a turbine by McAdam, of Belfast, with a consumption of 1,000 cubic feet of water per minute under a head of 35 ft.—pressure 20 ft., draught 15 ft.—drives the stamps, breakers, and Californian pans, and other plant used for gold extraction purposes by the company. The turbine deserves special notice. It was built of special design to suit circumstances, and continually runs from week's end to week's end—132 hours—without stoppage of any sort. The available head can be increased to 52 ft. if necessary. The estimated cost of the aqueduct was £1,050, and the actual sum expended on it £995, or about £2 9s. 9d. per linear foot of structure. White labor is dear, 16s. 8d. to 20s. being the daily wage.

The original surveys were made in September, 1888, and work was commenced May 27, 1889. The whole is from designs and surveys of Mr. Edward J. Way, C.E., F.I.C., etc., resident engineer, and erected under his personal supervision. The negatives from which the photographs sent to us were copied were the work of Mr. O. H. King, the company's metallurgist. The manager is Mr. John Spiers.

We give a view of a ten-stamp Morgenzon battery, 900 lb. stamps, by Harvey & Co. The whole was set out and erected from Mr. Way's plans and designs, and under his superintendence, and is now doing good work and increasing the gold output of the district. A very powerful water power is being put down, consisting of a specially designed wheel under a head of 650 ft. An aerial tram is also in course of erection, which will bring the ore to the mill direct from the mine, which is distant about 600 ft., and is about 350 ft. above the mill. Steam will be used in the dry season only. The manager of the company is Mr. D. C. Slatter.—*The Engineer.*

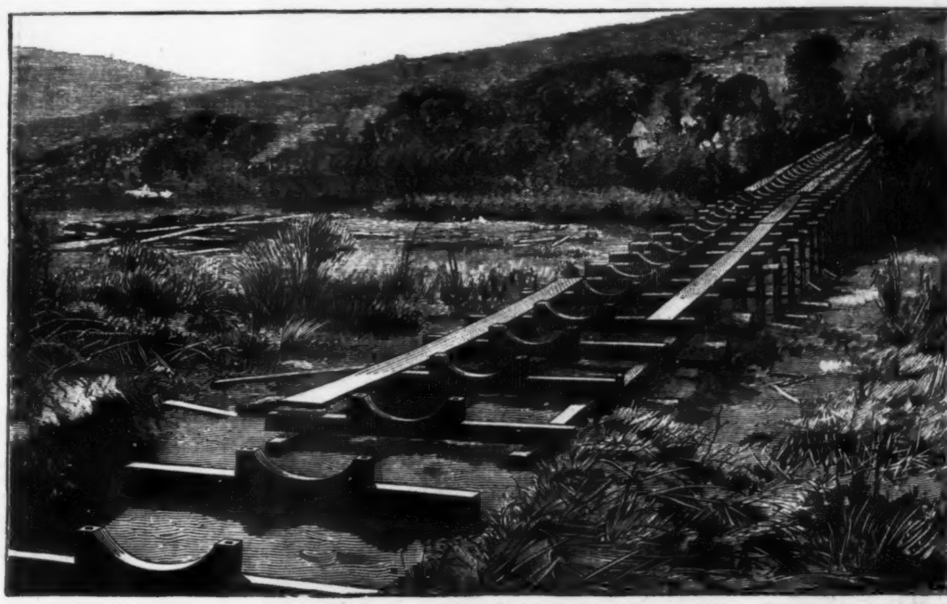


FIG. 1.—BEARERS OR CHAIRS TO CARRY PIPES.

FIG. 3.—TAIL TANK AND WATER CUSHION.

THE BLYDE RIVER AQUEDUCT, TRANSVAAL, AFRICA.

HOW TO MANAGE A STEAM ENGINE.

By J. C. S.

IN the first place, I would clean all the parts of an engine thoroughly. All gum and grease may be cleaned off by the use of coal oil or turpentine. Then place the engine and boiler on a foundation properly leveled up. All connections by steam or water pipes should have a good lead paint applied to their joints or couplings. If gas pipes are used for suction pipes, they should be connected in a perfectly air-tight way and all couplings well painted with lead. If convenient, let the paint dry before starting up the engine. Hand plates, too, should be painted and left to dry.

When everything is in running order, fill the boiler to about two gauges of water, and at this point it should be kept as near as possible when running. When shutting down in the evening, the boiler should be filled to the third gauge, so as to have plenty of water left after waste and shrinkage.

When firing up the first time, I should advise all to go a little slow. See that everything is all right as the steam rises. Make everything right and tight before a high pressure is reached. See that the pump starts off all right. If not, close your damper or shut off all draught until your pump is in running order and everything in first class shape.

I have had the best results in firing by laying the wood with the bark down or edgewise in the furnace or fire box, with a cross stick for the wood to rest on, as shown in Fig. 1, next page. This gives plenty of draught. I do as little stirring with the poker as possible, but keep filling in on top as fast as it burns out below. By this means the flames get a free circulation, the coals soon become ashes, and the grate bars do not become clogged.

I have seen firemen stir the fire upside down every time they fed it, throwing the bark and coals to the bottom of the fire box, choking off all draught through the grate bars. This not only makes it difficult to keep up steam, but leads to a waste of fuel.

It is the same way when firing with coal. A constant stirring throws valuable fuel into the ash pit. In fine coal a thickness of three or four inches is sufficient. When greater, the combustion is imperfect, wasting fuel and preventing the full power of the boiler being developed. A thin fire, frequently renewed, gives in every way the best results. The fuel should be the heaviest at the sides, to give a full supply of air on account of space left between the fuel and the walls.

Boilers are often injured by unequal expansion and contraction caused by a strong fire on one side, while there is a draught of cold air on the other. If a boiler steams too fast, close the dampers and shut off the draught. Fire doors should never be thrown open, if it can be avoided, or kept open longer than absolutely necessary, as it is injurious to the boiler and wasteful of the fuel.

Keep the ash pit and smoke chamber cleaned of ashes and soot, and the flues swabbed out every day. A good engineer will keep his boiler and engine clean inside and out. The boiler should be examined often, and if lime has accumulated, it should be cleaned out. There are some kinds of incrustation powders that are good. Soda ash is said to be first rate. I always manage to keep enough white oak bark in the water to color it a little. This helps to keep a boiler clean of scale. A few white potatoes put in the boiler when it is blowing out answers the purpose very well and will not injure the iron.

A boiler should never be blown out while hot and at a high pressure of steam. It should be left to cool down and blown out at a low pressure. The deposits of mud will then not bake into a hard scale that becomes attached to the surface. Many engineers suppose that blowing out a boiler under pressure has a tendency to remove these deposits from a boiler, but experience has shown this to be a very grave mistake. When the feed water is muddy or impure, I manage to blow off a little every day or two. Try this, brother engineers, and you will be surprised at the results.

The supply pipe next the boiler sometimes gets stopped with lime. It is necessary to clean this out. It may be done by taking out the check valve and punching out the lime with an iron rod. There should always be a stop cock or valve close up to the boiler, and whenever anything gets under the check valve, the cock or valve next the boiler may be turned so as to shut the water off from the boiler. Unscrew the cap and take the valve out. Clean it and place it back again. Don't forget to open the stop valve before starting the pump. This stop valve next the boiler should be shut every night in cold weather and the waste cocks (or petit cocks) should be opened. This will free the valves and pipes from water and prevent danger of bursting from freezing. If a pump is used it should be packed with the best of packing, as a pump will not work good if not properly packed, and here is where the defect is mostly when the pump does not work. After the pump is started and seems to be working then close the water (or petit) cocks, which should be opened when the pump stops working, or is stopped, so as to let the water out of the heater pipes. If you neglect to open this water cock, the hot water left in the pipes will heat the pump; a hot pump will not work.

Some pumps can be gauged so that the feed may be constant. Should the pump valves wear out of true or become leaky, they may be refitted by ground emery and oil. To grind a pump valve true again, mix emery* with oil and place it between the valve and its seat and then take a carpenter's brace, fasten it to the center of the valve, and turn it until the valve is ground all round its bearings and seems to fit all right. Good oil should be used frequently, but not lavishly. A little applied often is better than a good deal less frequently. Good fresh, pure tallow † is a very good lubricant for the valve and cylinder.

The cylinder cocks should always be opened when the engine stops or is not in motion. After the engine is started and the water is out of the cylinder, close the cocks; in case of foaming or priming, open the cylinder cocks; in case of violent foaming, caused by dirty or impure water or a change of water, close the throttle and keep closed long enough to show the true level of water. If that level is sufficiently high, feeding and blowing out will usually correct the evil.

Gauge cocks should be kept clear and in constant use. The glass gauge should not be relied on altogether, as often it will get clogged up and not show the true level of the water. To clean the glass gauge, the water should be let out by opening the petit or water cock at the bottom of the glass. Let the steam and water blow through it a little, then close the lower valve first. The steam blowing through the glass will clean it. Then by shutting the open valve and leaving the water cock open below, the water and steam are shut out of the glass, as it should be every night in freezing weather. If at any time there should occur low water in the boiler, immediately stop the engine and bank or cover the fire with ashes or fresh coal or sawdust. Close the draught, and if there is sufficient water to cover the flues, turn on the feed moderately; let the steam outlets remain as they are. But if the water is out of sight, draw the fire out as soon as possible and let the boiler cool down to a low pressure before any attempt is made to turn on the feed. The safest way is to fill the boiler by hand.

Fig. 1.—SHOWING HOW TO GET THE BEST RESULTS IN FIRING.

Safety valves should be noticed frequently, as they are liable to become fast in their seats and useless for the purpose intended. Should the steam gauge at any time indicate the limits of pressure allowed, see that the safety valve is blowing off. In case of difference, find out which is wrong and should be rectified.

If at any time a pounding sound is heard, I should stop the engine at once and find out the defective place. The best way to detect the defect is by blocking the crosshead at the mid-stroke or top quarter. (See Fig. 2.) Then take two blocks of wood and block the crosshead, a block on each side, as B, Fig. 2, tight enough so there is no play. Then I have a man take hold of the band or balance wheel and give quick, short jerks back and forward, at the same time closely watching all the bearings, and if there is too much play in the wrist pin box or crosshead box, I tighten them up so there is scarcely any play at all, or just enough so the bearing will not heat when properly oiled.

If the oil cup should not feed the wrist pin properly, it will heat and stop the engine. If there should occur too much play in the pillow block box or cap, it should be tightened with care, so as not to get the shaft out of line, causing more trouble by heating the boxes. An engine performing irregular work is more liable to this defect of thumping. Saw mill engines, on account of irregular power used, should be closely watched, and if at any time an unnatural sound is heard, the defective place should be looked for. Sometimes the piston head or rings become misplaced by set screws or bolts dropping out, and danger of wrecking the engine is imminent. The eccentric straps should be adjusted so as to do the work and not rattle. The joint or bearings and valve-stem guide should have but little play. Quite often the eccentric becomes misplaced, causing the valve not to perform correctly, or the valve slips on its stem, or misplacement of any part will misplace the valve. If at any time I suspect that

* Emery should not be used in grinding in valves. Grindstone grit or parting sand from the foundry answers every purpose and avoids the cutting sure to follow the use of emery.—Ed. S. A.

† Mineral oils are preferable to tallow. The acid found in tallow is injurious to the cylinder and valves.—Ed. S. A.

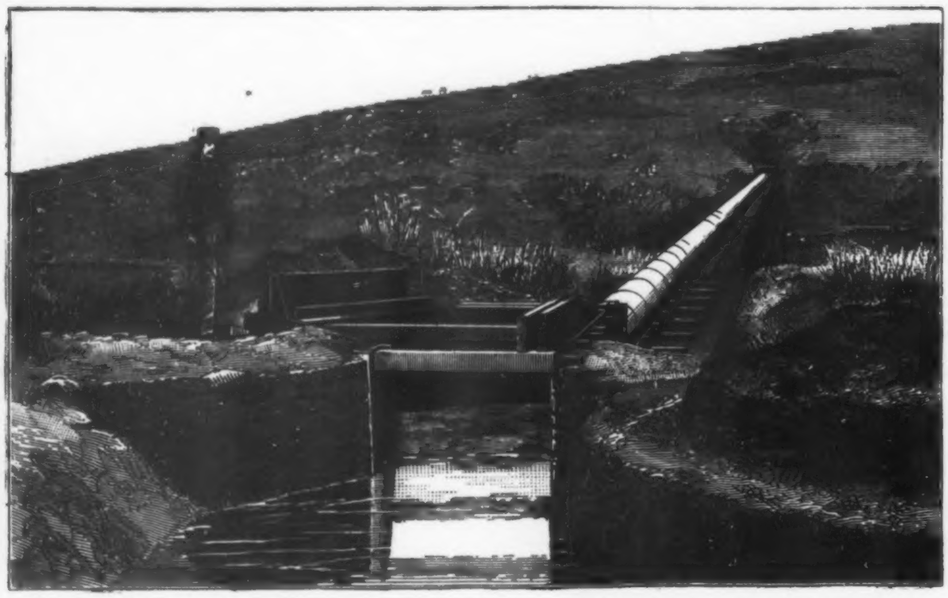


Fig. 2.—INLET AND HEAD TANK WITH BYWASH. FOOTWAY PARTIALLY FINISHED.

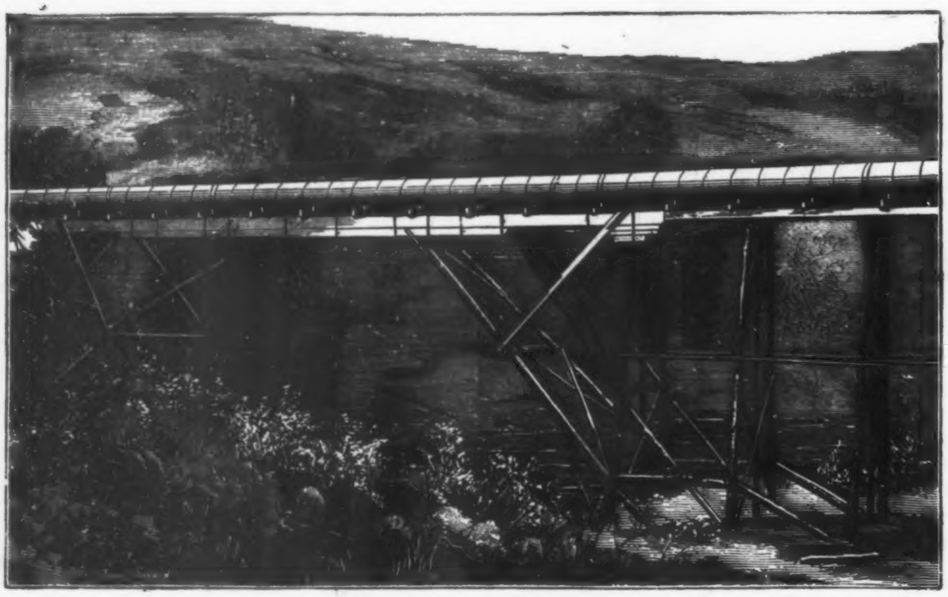


Fig. 4.—SPAN (75 FT.) ACROSS RIVER BLYDE.

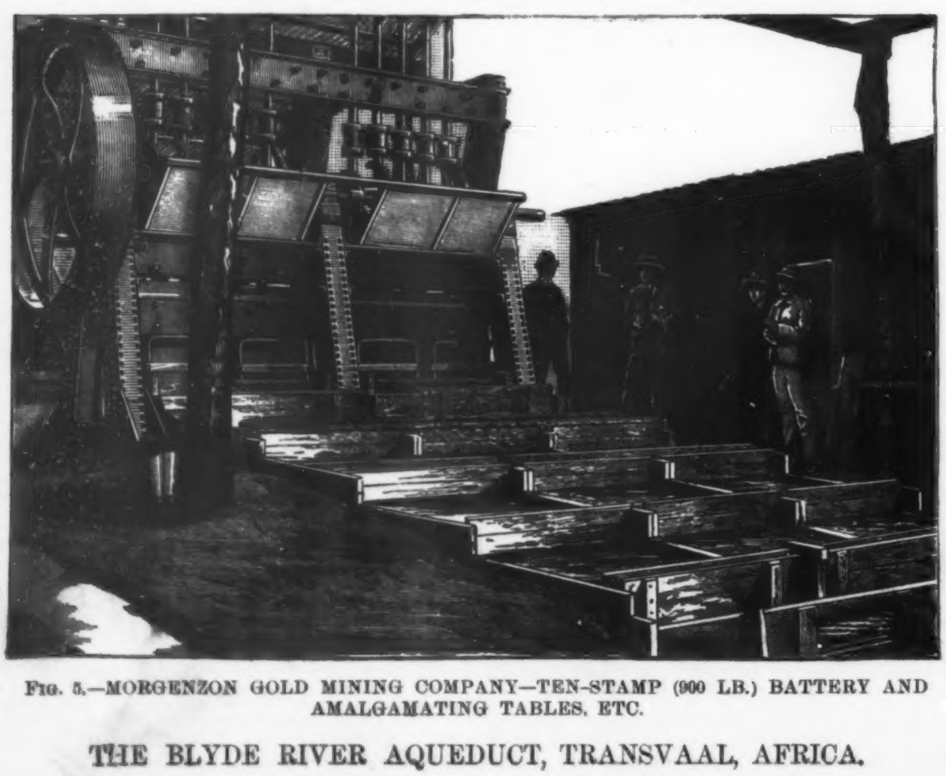


Fig. 5.—MORGENZON GOLD MINING COMPANY—TEN-STAMP (900 LB.) BATTERY AND AMALGAMATING TABLES, ETC.

THE BLYDE RIVER AQUEDUCT, TRANSVAAL, AFRICA.

the valve is not performing correctly, I take off the steam chest lid and turn the engine or crank pin on its dead center (on either center). The wrist pin being on a

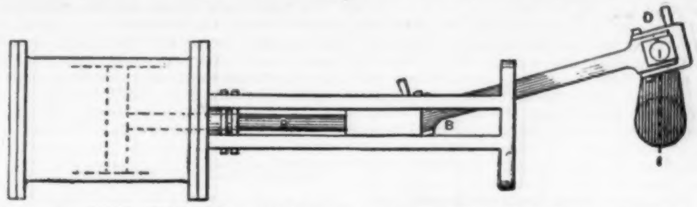


FIG. 2.—THE WRITER'S METHOD OF DETECTING THE DEFECT WHEN A POUNDING SOUND IS HEARD.

straight line with connecting rod and piston rod (see Fig. 3), the crank being on the dead center, F, the steam port, A, will be opened by the valve to the amount of lead, or the position of the eccentric would be D C, according to the lead given to the valve, or there should appear an opening of steam port, A, $\frac{1}{32}$ of an inch to $\frac{1}{16}$ of an inch, according to the kind of engine, a large fast runner needing more lead than a slower engine. Then turn the engine the way it runs to the opposite center from E to F, the stroke to be from E to F, as indicated by the arrow. Then the opening in front of the valve at steam port, B, should correspond to the opening that was at the other end. If any larger or smaller it is wrong, and should be corrected. To open the space, the eccentric should be loosened, and always turned the way the engine runs until the opening appears as desired.

If the opening is too large, the eccentric should be turned the opposite way from that in which the engine runs, and that will close it up. If one end opens wider than the other, the openings must be equalized by the use of the nuts on the cam rod at the cam yoke, or if the derangements have occurred at the valve stem rod, correction must be made there. In setting the valve, the engine should always be turned the way it runs—never backward.

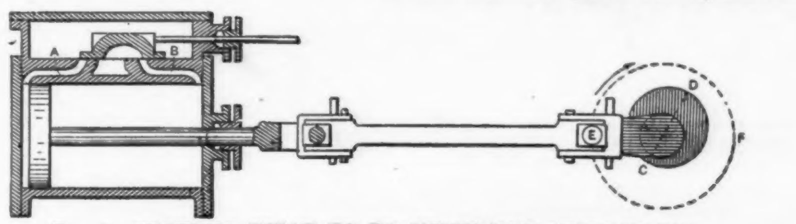


FIG. 3.—SHOWING WHAT TO DO WHEN YOU SUSPECT THE VALVE IS NOT PERFORMING CORRECTLY.

An engine sitting on top of a boiler, and pillow blocks fastened to the boiler, the valve should be set when the boiler is fired up, as the expansion of the boiler will misplace the valve if set perfectly when the boiler is cold. In stationary engines the correct way is to set the valve when hot with the proper amount of lead for her regular speed. Varying speeds are not desirable. One sixteenth of an inch lead or port opening, when the engine is on its dead center, will give admission of steam before the piston gets to the end of its travel, or about at point 0·99 (see Fig. 4). A 12-inch

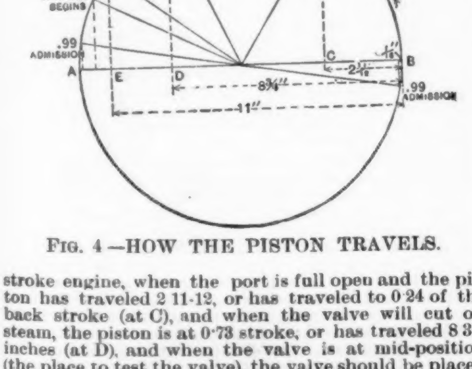


FIG. 4.—HOW THE PISTON TRAVELS.

stroke engine, when the port is full open and the piston has traveled 2 11-12, or has traveled to 0·24 of the back stroke (at C), and when the valve will cut off steam, the piston is at 0·73 stroke, or has traveled 8 3-4 inches (at D), and when the valve is at mid-position (the place to test the valve), the valve should be placed in this position before putting on the steam chest lid, and a mark put on its stem and a corresponding locating mark on some immovable part, not on the stuffing

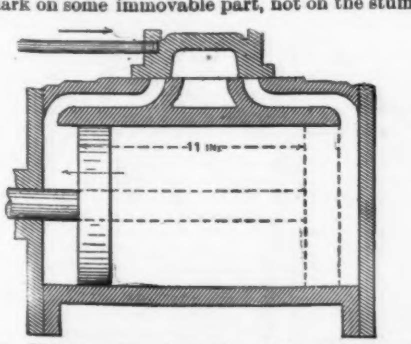


FIG. 5.—WHEN THE PISTON HAS TRAVELED 11 INCHES.

box gland. When the valve is on this central position the piston is at a point 0·92, or has traveled 11 inches on its forward stroke, and is near its crank end (see Fig. 4 and Fig. 5). This percentage holds good on any sliding valve engine for 1-16 inch lead. If more lead is given, all the points will be earlier. 1-8 inch lead of the valve. The piston will travel 2 1-2 inches by the time the steam port is full open. In a larger engine than 12-inch stroke, the piston will have to travel farther, and in a smaller engine the travel will be less in inches to get the percentage points.

I could give compression and exhaust points, but as the valves vary in the exhaust lap, or valve exhaust

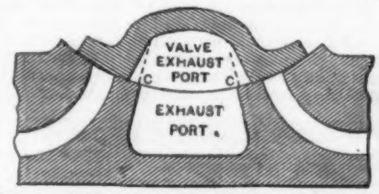


FIG. 6.—THE VALVE EXHAUST PORT.

port, these points would vary. A valve should have plenty of room in the valve exhaust port and exhaust port. I have cut out the valve exhaust port (see Fig. 6, CC). This defect I have remedied on a rack or rotary valve. This same valve over-traveled—over-traveling is where the steam edge of the valve passes the end port (A, Fig. 7) and travels over on to the bar (B) or bridge, nearly closing the exhaust port by the exhaust edge of the port valve leg (see Fig. 7, L); although there was two-thirds or three-fourths cylinder full of exhaust

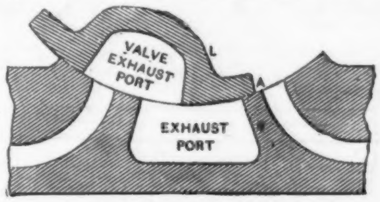


FIG. 7.—OVER-TRAVELING VALVE.

steam to be driven out on the exhaust side of the piston.

This engine was a throttling engine, true to the name. The throw of the eccentric was too large, causing the exhaust port to be throttled, making too much back pressure, the piston working against its own steam. This defect I remedied by a longer crank or lever, with a long hole at the lower end, so I could change the eccentric rod up and down, changing the cut-off (see Fig. 8).

The throw of an eccentric may be too small, the valve not quite opening the port (Fig. 9), or the valve may

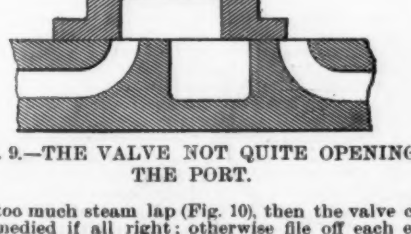


FIG. 9.—THE VALVE NOT QUITE OPENING THE PORT.

have too much steam lap (Fig. 10), then the valve can be remedied if all right; otherwise file off each end alike on the outside edge of the valve leg or steam lap, as the steam laps are not alike on a valve (or at least should not be on a common slide valve engine).

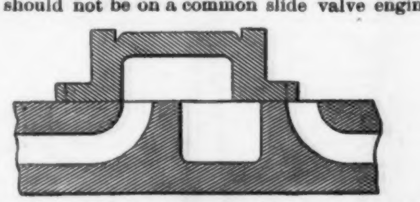


FIG. 10.—VALVE LEG HAVING TOO MUCH LOOP.

These should be filed off no more on one side than the other. The throw of an eccentric is the distance of the center of the steam from the shaft center.

A more correct method of finding the throw is by subtracting the height at the low side from that of the height, as shown in Fig. 11; A, low side; C, center of shaft; B, high side. The remainder equals the valve travel.

But I should advise no one to meddle with the valve unless he understands what is wrong with it. A valve is a very important part of an engine, and should work as near right as it can be made to do. To test the slide or any valve to find out if it leaks steam, the tightness of the valve may be tested by blocking the engine in such a position that the valve will stand central over

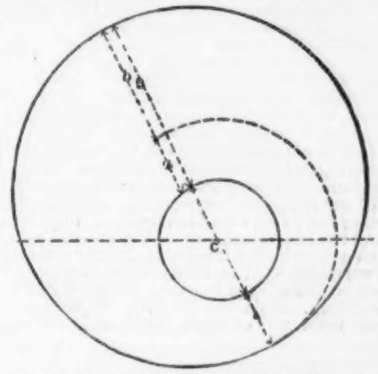


FIG. 11.—TO FIND THE THROW OF AN ECCENTRIC.

the ports covering them, or when the piston is at 0·92 of its stroke, by the means of the scribe marks on the valve stem. Let steam into the chest, and if any steam escapes through the cylinder cocks, the valve leaks and ought to be repaired.

Flat valves when worn so as to leak can easily be refitted by scraping or grinding with oil and ground emery.* The valve is the vital part of an engine, and anything which affects its durability or impairs its efficiency will affect the whole engine to a greater extent than the failure of any other part.

A common slide valve engine may be much more truly economical than even an automatic engine, if the latter, through any defective principle, requires frequent and expensive repairs. Flat valves, unless they wear unevenly, will stand a very large amount of wear before any steam can blow through; but with a piston or rotary valve, the moment it wears, that instant it begins to leak, and when steam gets a chance to blow through even a small opening, the opening is rapidly enlarged by the friction and cutting action of the steam. A mere pin hole in a boiler, for instance, if not stopped up, becomes from this very much larger in a short time. The same action operates to destroy a valve.

Any form of valve which will not admit of wear without leaking is one of the most troublesome things to deal with. Where piston or rotary valves are used, it

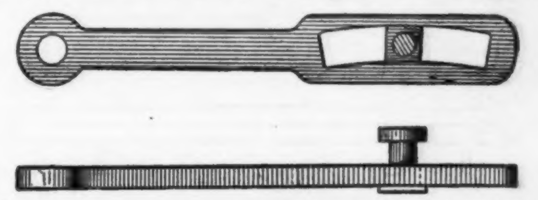


FIG. 8.—LEVER FOR CHANGING THE ECCENTRIC.

is the unequal wearing of both valve and valve seat, and any scraping or other operation to true up the valve only makes it that much smaller. With the valve seat a similar operation renders it larger than before. Consequently the fit is lost.

If the piston or packing rings should leak steam, the tightness of the rings may be tested by blocking the engine on the top or bottom quarters (as in Fig. 2), and on opening the throttle, if steam escapes at both cylinder cocks, the rings are not tight enough. Or a more correct test is by blocking the engine at the point that the valve has opened a steam port, or where the crank pin stands two thirds of the way between dead center and first quarter (see Fig. 12). Then open the

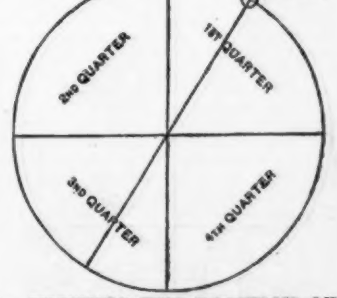


FIG. 12.—SHOWING THE POSITION OF THE CRANK PIN.

throttle and open only the cylinder cock opposite the steam pressure, and if steam escapes the rings are not tight enough, and they should be taken out and expanded, or they should be replaced with a new set. They should be run as loosely as will permit being steam tight under the maximum steam pressure that is put on them.

There are various kinds of packing rings. Some are set with screws. In setting these the piston rod must

* The use of emery is not advisable in this connection. If the valve is carefully scraped it will soon acquire a perfect surface in use; whereas if emery is employed it can never be entirely removed, and cutting will result.—ED. S. A.

be kept central. There would be no harm in having a counter bore at each end of the cylinder, so as to prevent the piston from wearing a shoulder, the piston traveling beyond the beginning of the counter bore, as there is nothing for its edges to wear a shoulder on. So, if there was any change in the travel of the piston by which its stroke was increased, or the stroke being changed in length or shortened, there would be no shoulder to strike and a smash-up likely to occur. The stroke of the piston lengthens or shortens, on account of such an arrangement of adjustment in the connecting rod brasses or in the fastenings of the piston rod, either in the cross head or in the piston head, or a change in the main bearing brasses as would move the piston head toward or from the main bearing. The key for the cross head pin is in front of the pin, and that of the crank pin is behind the crank pin, and as the brasses wear and the keys are driven up, the pins would be driven farther apart, causing the stroke of the piston to change in the bore. If there should not be very much head clearance, there is some danger of the piston head striking the cylinder head, and a good deal more liability of there being an accident by reason of water in the decreased clearance space. The connecting rod should be disconnected from the cross head, and the piston head should be shoved up until it touches each cylinder head and danger marks on the guides, corresponding to the cross head, so as to show if the piston head is too near the cylinder heads when all is keyed up. This can be done by taking hold of the cross head pin or cross head, and shoving it or pulling it to either end. Both ends should be marked, and don't forget that the piston travels farther in the first and fourth quarter of the crank revolution or the back end of the stroke.

All the keys about an engine should be noticed frequently, as often they will work out and cause serious smash-ups. The writer had a little experience in this line. When a key flew out of the connecting rod at the crank end, the set screw became loose, thus giving the piston full liberty to wreck the engine, which it did before the throttle could be stopped. I have knowledge of another engine to which this occurred, and a serious smash-up was the result. If a key is apt to work out, there should be a hole drilled through the lower end and a wire key or a rod nail put in and bent so it will stay in. An engineer should always be a wide-awake fellow, one that can keep an eye on the engine all the time, and will notice if a bar or bolt or any part is working loose; and if at any time there are indications that some part of the engine needs repairing or tightening up, or new packing, do it at once. If your engine at any time exhausts hard or seems to work against its steam, or there is more back pressure than there should be, examine the exhaust pipe, as it is liable to get corroded or closed up in the smokestack. I have seen an engine of this kind that was hauled to the repair shop and repairs made to the piston, and then started up with no better results, until some of the best engineers were called to see the engine work, and finally the exhaust pipe taken apart. Where it entered the smokestack, where the pipe was turned up, was the defective place that caused so much trouble. So any one that has not learned the trade of taking care of an engine has no business with one.

To take care of an engine right, as it ought to be taken care of, there is need of a good, ingenious, sober, cool-headed man; not one that gets excited and rips or swears and tears around so it is sometimes not safe for any one to be near him. Such a man ought not to be employed more than eight hours; that is as long as I would want to employ him. Good men are as much needed as good machinery.—*Saw-mill Gazette.*

COMPRESSED AIR TRAMCAR PROPULSION.

On a tramway at Chester Messrs. Hughes & Lancaster are running a tramcar worked by means of a compressed air motor, supplied with air at about 155 lb. per square inch. This air is carried in vessels attached to the car, and will be made to form part of it. The air supply is renewed at intervals on the journey by an automatic valve on the car. A corresponding valve is placed on an air main which is laid the whole length of the tramway, and similar valves are placed at intervals of from half a mile to two miles, according to the character of the road and the traffic. Where the road has heavy gradients, and where the traffic is exceptional, they will be placed at the smaller intervals. Air can thus be taken when required, just as the London and Northwestern engines can take up water on the road. The system referred to is one of great importance, and seems to offer the best solution yet pre-

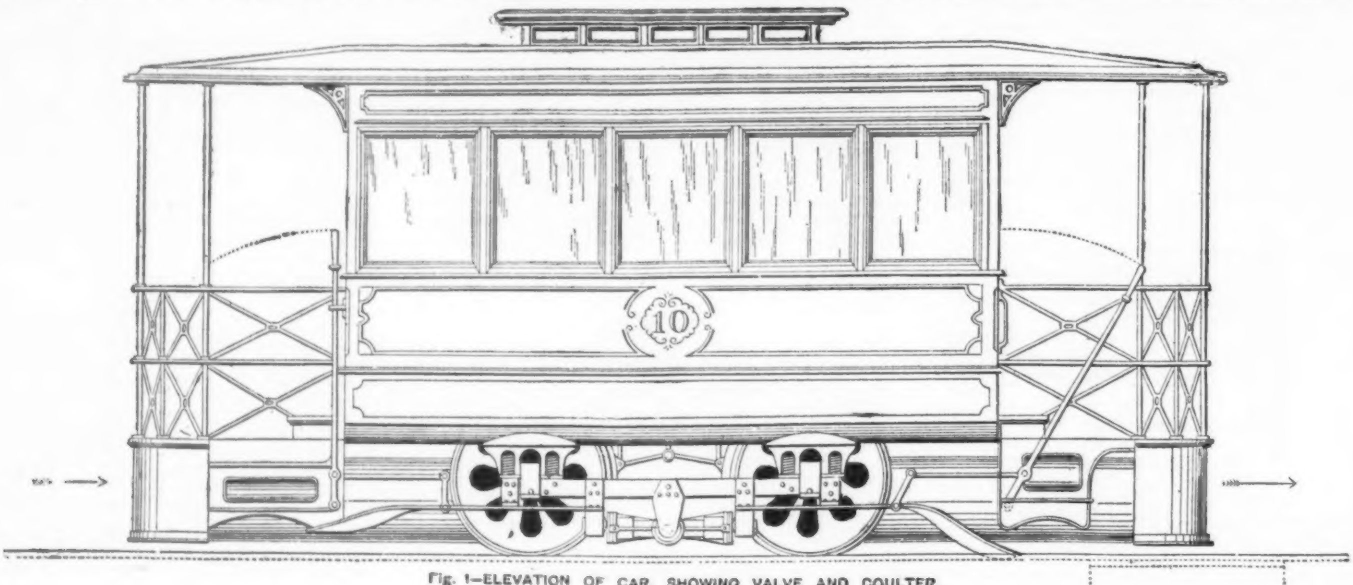


Fig. 1—ELEVATION OF CAR, SHOWING VALVE AND COULTER.

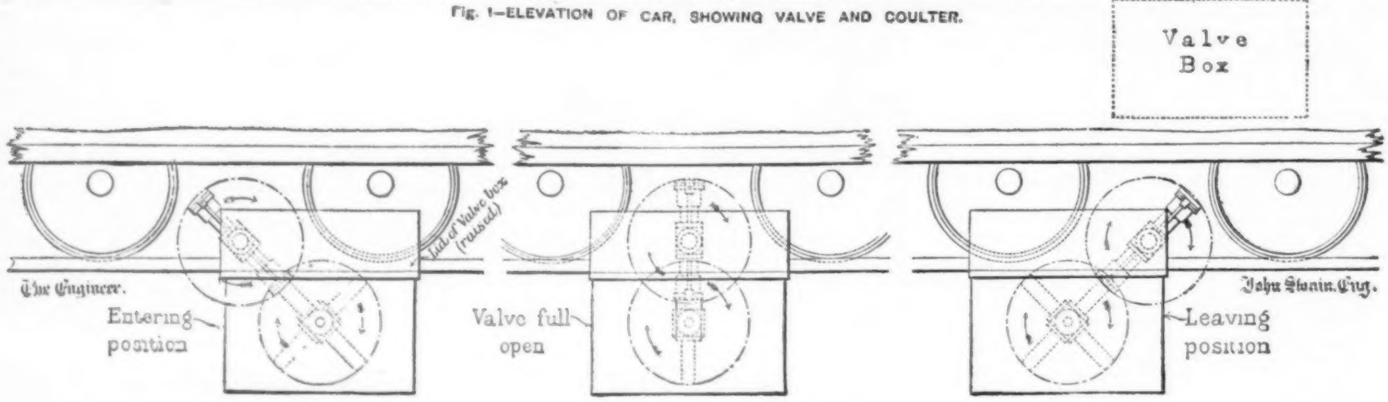
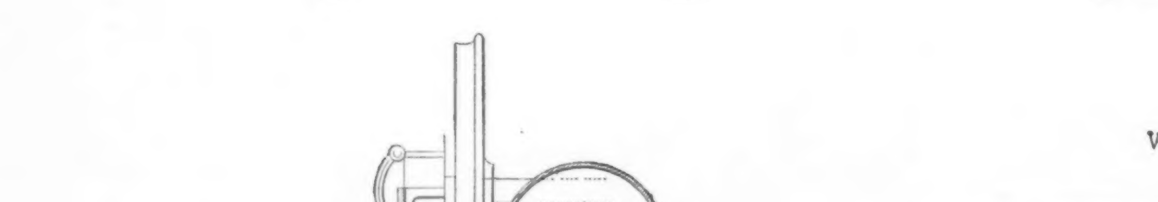
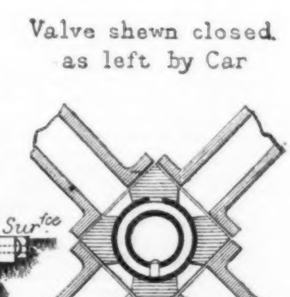


Fig. 2 Fig. 3 Fig. 4





END VIEW with end of box cut away

Figs. 5 & 6.

SIDE VIEW with side of box cut away.

ENLARGED SECTION

Fig. 7

COMPRESSED AIR TRAMCAR.

sented of the tramcar propulsion difficulty. Electrical propulsion is theoretically more perfect, inasmuch as the generator has a higher efficiency than an air compressor, and an electrical motor a higher efficiency than an air motor; but it has to be admitted that these efficiencies have not hitherto enabled electrical engineers to propel tramcars with that economy which is necessary to constitute a sufficient reason to adopt electricity in place of other means of propulsion. The difficulty, which does not seem to decrease, arises mainly from the exigencies of the permanent way, including the mode of collection, but it cannot be said that the necessary intermediary parts between the motor and the driving axles have arrived at a thoroughly satisfactory practical form.

The compressed air, on the other hand, requires nothing in permanent way which is not of every-day use, and the difficulty of the supply of air to the car has now been removed by the use of apparatus which may be looked upon as similar to well tried mechanical appliances. In the compressed air system hitherto proposed, the air necessary for the car journeys has been all stored under heavy pressure in the vessels carried by the car. The main objections to the system are the great loss of efficiency arising from the use of highly compressed air; and secondly, to the complete dependence of the car upon the capacity of the air vessels it carries. All these difficulties are overcome by the low pressure system and the new apparatus above referred to and illustrated herewith.

In the illustrations, Fig. 1 is a general view of the car in use at Chester, an old one fitted with the necessary apparatus, but not quite satisfactory, as the apparatus had to conform to conditions unnecessary if a special car had been made. At either end of the car will be seen a hand lever. This is attached to a coulter, which is used when it is necessary on the road to take in a new supply of air. This coulter, when dropped, raises a cover plate over the hole or box in which is fixed one of the valves referred to on the air main, which runs parallel with the tramway. When this cover is lifted to a vertical position it presents on the side next the car a pair of grooves or guiding channels, see Fig. 6, which have the following object and action. In the center of the car, and between the two wheels on the side shown, will be seen a double-ended valve box rotating on the center of its length, as shown by Figs. 2, 3, and 4, and by the enlarged section, Fig. 7. Below the level of the ground is shown, in Fig. 1, the position of a valve box. On the platform of the car, at the end near the valve box, will be seen the lever by which a coulter is dropped into a groove outside the rail. As the car proceeds this coulter lifts the box cover to the position shown in Figs. 2 to 6. Having lifted this cover, a small roller at either end of the valve box on the car enters the groove seen in Fig. 6. As soon as it does this the car valve, with the motion of the car, is tilted to the position shown in Fig. 2. The socket end of the car valve is thus placed so that the continued movement of the car causes one of the four hollow arms of the valve, Fig. 7, to enter it, see Fig. 2. With the further movement of the car, the relative positions of the car valve and valve in the main box are as shown in Fig. 3. In this position the valves are fully open, and the air from the main rapidly fills the receiver upon the car. It is possible thus to take air while the car continues its motion; but the better way is always to stop the car a few seconds when in the position seen in Fig. 3.

As a matter of fact, the air pressure on the area of the spigot of the valve is sufficient to arrest the car at the slow velocity at which the conductor allows it to approach and enter upon the valve. From 15 seconds to 40 seconds will always be sufficient, and the stop may always be at a recognized place. The car moving on causes the four-armed valve to rotate, cut off air supply, and the two-armed valve on the car leaves as shown at Fig. 4, the latter valve being guided by the grooves on the cover, and caused automatically to take the position seen in Fig. 4, and before it leaves the cover it has taken the position seen in Fig. 1. The whole of these movements are automatic, the conductor having only to lower the coulter, and raise it after the valve box is left behind.

This apparatus works quite satisfactorily, and there does not seem to be any reason for supposing that any practical difficulty in its working will arise. This being the case, we may conclude that the Hughes & Lancaster system provides a satisfactory practical and workable means of supplying tramcars with compressed air for their propulsion along their route; that is to say, then, that the car may be assumed independent of any considerations of supply. The next question is that of the motor by which the compressed air is to be used and power conveyed to the car wheels. On this point it may be said that as the air motor need not differ in any material sense from a steam engine, there need be no difficulty on its account; and as steam engines have for considerable time worked tramcars, and as methods of gearing suitable for communication from motor to car axle are known and well tried, it may be assumed that no difficulty should arise on this point. This must be admitted, although the experimental apparatus not being free from objections, new motors and gearing are being made. The question which remains, then, is that of cost.

It might perhaps be said that as the power required to drive a tramcar is very well known within limits, it follows that the cost of propulsion by means of air compressed at say 170 lb. per square inch, and used at 155 lb. per square inch, is readily derivable by every engineer. The car at work has air vessels containing only about 52 cubic feet; but assuming that the conditions of some experimental runs made with the car by Professor Unwin last July remain the same, but the vessels carry 100 cubic feet, and that the car weighs 6 tons, instead of 5 tons 9 cwt., assumed loaded, then the following figures from Professor Unwin's report show the expenditure of air under the circumstances:

TABLE I.

Gradient.	Resistance in lb. of six ton car.	Initial pressure above atm. lb. per sq. in.	Final pressure above atm. lb. per sq. in.	Lb. of air used in run.	Work in traction per lb. of air used ft. lb.	Distance run before stopping, in feet.
Level.	162	170	18	78·77	14,510	7,055
1 in 150	252	170	28	73·60	13,790	4,028
1 " 75	342	170	38	68·42	13,010	2,603
1 " 50	430	170	48	63·24	12,340	1,814
1 " 25	608	170	76	48·72	11,020	769

Subsequent experiments have been made by Mr. D. K. Clark, from some of which the following figures have been obtained:

TABLE II.

Table showing Amount of Air consumed on Various Gradients.

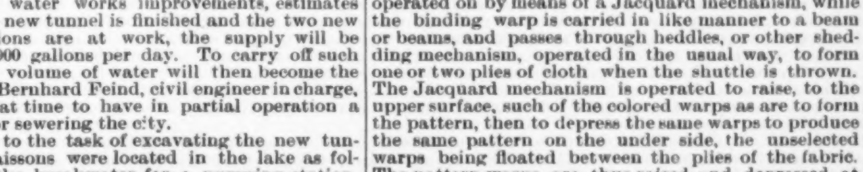
Gradient.	Lb. of air used per yard run.	Gradient.	Lb. of air used per yard run.
Level.	0·0221	1 in 70	0·0483
1 in 1,000	0·0240	1 " 65	0·0503
1 " 750	0·0245	1 " 60	0·0526
1 " 500	0·0258	1 " 55	0·0554
1 " 400	0·0267	1 " 50	0·0586
1 " 300	0·0282	1 " 45	0·0627
1 " 200	0·0312	1 " 40	0·0679
1 " 150	0·0344	1 " 35	0·0745
1 " 100	0·0404	1 " 30	0·0832
1 " 90	0·0424	1 " 25	0·0952
1 " 80	0·0450	1 " 20	0·1138
1 " 75	0 0466	1 " 15	0·1442

From these figures it will be seen that with the apparatus at present employed the cost of the air used would be small, and it may be inferred that the cost of fuel for the large fixed engines which would be used at the air-compressing station would not exceed about one penny per car mile. Taking the above figures, and assuming the cost of coal to be 10s. per ton, and the engine to use 3 lb. per horse power per hour delivered to the air compressors, Messrs. Hughes & Lancaster make the cost of fuel about two-thirds of a penny per car mile. If, however, the resistance of the car be taken as a mean of the first four lines in table I., namely, 300 lb., then the horse power, net, is 4·75, that is to say, 4·75 horse power actual is required at the car axles. The various losses between the engine driving a compressor, in the compressor, in the main, and in the motor, will reduce the horse power of the compressor engine to about 0·35 of a horse power at the motor on the car. Between this motor and the car axle there must be gearing which will absorb about 25 per cent. of its power. Taking these quantities into account, the total horse power at the compressing engine for driving one 6 ton car at six miles per hour will be 17 horse power, and taking the same consumption of coal, the cost at 20s. per ton will be $\frac{17 \times 3 \times 0{\cdot}107}{6} =$ 0·91d. per car mile. This, it must be remembered, is the cost for fuel alone. But even if this be largely exceeded, the cost for fuel would be a small matter as compared with the cost for horse feed; and in comparison with other systems of propulsion, this one offers the great advantage that every car is perfectly independent.—*The Engineer.*

CHICAGO WATER SUPPLY.

THE NEW TUNNEL UNDER LAKE MICHIGAN, FOUR MILES IN LENGTH.

BY reason of her extensive system of aqueducts and subterranean passages already completed and in process of formation, Chicago may eventually become known as the City of Tunnels.



THE NEW LAKE TUNNEL, CHICAGO.

The new water works tunnel now being constructed at Park Row and Michigan Avenue will be, when completed, the biggest thing of its kind ever attempted, and a needed addition to the present system. W. R. Northway, city civil engineer, who has general supervision of the water works improvements, estimates that when the new tunnel is finished and the two new pumping stations are at work, the supply will be about 260,000,000 gallons per day. To carry off such an enormous volume of water will then become the problem, but Bernhard Feind, civil engineer in charge, expects by that time to have in partial operation a perfect plan for sewering the city.

Preliminary to the task of excavating the new tunnel, cribs or caissons were located in the lake as follows: One at the breakwater for a pumping station, marked 2 on the diagram; another one at a point two and a half miles out, marked 3, built for structural purposes; and the permanent caisson intake, four miles from shore, marked 4.

One of the most interesting features connected with this stupendous work is the four-mile intake or permanent crib, located in forty feet of water so far from land as to be scarcely discernible, in comparison with which the old crib is made to appear right in town. Three weeks hence, when the headings from the intermediate and this outer shaft are completed, the capacity for speed on the tunnel work will be quadrupled, for then it will be progressing from four points instead of one. This large crib was built under the direct charge of General Charles Fitzsimmons.

Fifteen courses of heavy timbers are at the foundation, and upon these rest two massive iron rings—one within the other—25 feet high, the outer ring measuring 125 feet, and the inner one 70 feet in diameter. The intervening space is divided by iron partitions into twenty-four compartments, filled with concrete. Above these comes a granite coping, 10 feet high. The seventy feet of space within the inner circle is solidly braced by five series of iron trusses, the same that are used in bridge building, giving great solidity to the structure.

In the center of the circle is located a shaft 12 feet in diameter and 110 feet in depth, through which, when the proper time comes, water is to be admitted. The water will reach this shaft through no less than six ports, five feet square, placed equidistant in the outer wall. Twenty-six thousand tons of material were used in the construction of the crib. The object of making so massive a structure is to secure it against disturbance from storms and to avoid the necessity of building around it a breakwater, which was found necessary in the case of the intake of the original water works. A lighthouse to warn vessels of the proximity of the caisson is to be established on the crib.

Andrew Onderdonk, contractor of the tunnel, has agreed to make the excavation for $750,000. The transit instrument in use is of the most expensive pattern, and being something remarkable in its way, like Katisha's elbow, people come miles to see it, especially engineers. It was manufactured by a Chicago firm and cost the city $800. By its aid a man's features are easily recognizable at the four-mile crib.

The most primitive geological formation which has been cut into is a bed rock of limestone. Resting upon this is a layer of quicksand, from six to ten feet. Above this is an uneven deposit of bowlder clay from five to twenty-five feet, and on top of the clay was found a water-bearing vein of silt varying from one to sixteen feet. Resting upon this is a deposit of blue clay, from thirty to sixty feet, and over that is another layer of quicksand, and then comes the stratum of vegetable mould which constitutes the bed of Lake Michigan. Every effort has been made, as far as possible, to keep the excavation within the hardpan stratum. The land shaft was sunk in December, 1887, and Mr. Onderdonk is to complete his work in three and a half years from the time of beginning. There will be no pipes placed in the circular tunnel to convey the water, for the thing itself is a water-tight conduit.

The work within the city, consisting of 9,438 feet of tunneling, was constructed from six shafts located at convenient intervals. The inland ducts are six, seven, and eight feet in diameter.

At the Harrison Street pumping works the machinery and pumps are nearly all in place and ready for the flow of water. The building at the Fourteenth Street station has not been erected, but the foundations for the pumping engines are completed, and the superstructure will soon be under way.—*Inter-Ocean.*

MANUFACTURE OF TAPESTRY, BRUSSELS, PLUSH OR PILE, AND SIMILAR FABRICS.

THIS invention relates to the manufacture of tapestry, Brussels, plush or pile, and similar fabrics, for carpets, curtains, and the like, and it has for its object the production, in a weaving loom, of the same pattern and coloring on both sides, or surfaces, of the fabric, and by which, in the case of pile carpets and rugs in particular, an imitation of hand-made Axminster fabrics is obtained, firmness equal to that secured by hand knotting being given to the individual piles of cloth. In the manufacture of such carpets and rugs in looms as previously attempted the pattern of the back of the fabric has been marred, and the coloring mixed, owing to the binding warps employed to secure the pile and to form the cloth being carried over the weft, and floating colored or pattern warps, and pressing the latter through between the warps forming the pattern at the back. According to this invention, however, this defect is overcome by forming practically two plies of cloth in the fabric, the binding or twilling warps, which may be introduced to bind the pattern warps in either or both plies, being in no case carried from one ply to the other, or allowed to pass through the floating colored warp. In carrying out the invention, an ordinary Brussels carpet or similar loom is employed, and the colored warps, by which the pattern is formed, are carried from the fell to a bank or banks of bobbins at the rear of the loom through mails which are operated on by means of a Jacquard mechanism, while the binding warp is carried in like manner to a beam or beams, and passes through heddles, or other shedding mechanism, operated in the usual way, to form one or two plies of cloth when the shuttle is thrown. The Jacquard mechanism is operated to raise, to the upper surface, such of the colored warps as are to form the pattern, then to depress the same warps to produce the same pattern on the under side, the unselected warps being floated between the plies of the fabric. The pattern warps are thus raised and depressed at each throw of the shuttle, while the binding warps are similarly, but independently, acted on by the heddles to form cloth with the weft, either in the back ply alone to bind the pattern warp, in the case of cut pile fabrics, or both in the front and the back ply. In forming cut pile fabrics, each selected warp, after appearing at the upper surface, is carried down to the back of the under ply under the shuttle thread, then up to the front over the next shuttle thread, then down again for the next shot, and then up to the front—the pile-cutting blade or knife being inserted at each alternate raising of the pattern warp, and the pile thread thus being secured by two weft shots over it, but under the floating warps, and one intermediate weft shot under it but over the floating warps, as well as by the binding warps, when such are used in either the back or front ply. In weaving Brussels carpets, the usual pile-forming wires are used instead of the cutting blades or knives. The wire or knife may be used for one of the sides only, in which case a raised or plush pattern would appear on one surface, while the other would contain an equally distinct and similar pattern of plain tapestry; or, as fabrics where a raised or plush surface is required on both sides, the wire or knife may be thrown over the colored warps, which are depressed to form the pattern on the under side of the fabric, as well as under the colored warps when raised to form the pattern on the upper side of the fabric.

ON THE DRYING OF CERAMIC PRODUCTS.

THE rapidity with which we can dry a piece of pottery depends on the time required for the moisture at the center to get to the surface and on the resistance or rather the cohesion of the moulded article.

The more rapidly this transmission is made, the less the difference in power of retaining moisture is betwixt the center and the exterior surfaces.

If we could make this transmission so rapid as to be instantaneous, the entire piece of pottery during the whole process of drying would preserve a uniform degree of humidity. The result would be that the withdrawal of moisture would be the same in every portion of the object. There would consequently be no breakage or distortion, however rapidly the process of drying might be conducted.

Now the speed of the transmission of the water from the interior of the clayey mass depends essentially on the nature of the clay.

We are not able to give any theoretical explanation of this process, which is, of course, connected with the molecular constitution of the mass. It is the same also in regard to the plasticity of the clay, as to which we are equally ignorant of the cause. Of course, it may be said that the transmission of the water is caused by "capillary attraction," but that is really no explanation at all, because while a series of phenomena testified by experience are designated by this epithet, the rational explanation of them nobody has yet been able to supply. If we would study this subject of the transmission of humidity in ceramic products, we are bound to have recourse to actual and direct experience, but even then the small number of universally admitted facts does not permit us to arrive at positive and certain conclusions.

Up to the present time we know no method of hastening the transmission of humidity in a really clayey paste.

Within a recent period we have tried the effect of a more diluted atmosphere than the ordinary atmosphere. For this purpose we have put pieces of pottery recently moulded under the bell of a pneumatic machine, and we have operated with pressures made gradually more and more weak until we have reached a vacuum as perfect as the instruments could be made to achieve, and the result has been completely vain.

Nothing therefore remains as a resource but that we should modify the composition and nature of the paste itself.

Regarding this point of view, all practical men know that the transmission of the humidity is more slow, as the clay is more plastic and more compact. It is hastened therefore by making the clay more penetrable by the atmosphere around. As the less solid clay requires less water in its modeling, it is natural that it should dry all the quicker. These two processes go on simultaneously, and it is therefore difficult to attribute its own proper share in the process to either of them.

Thus two bricks, one of which was made of pure clay, and the other with a part of the same clay mixed with two parts of perfectly dry sand, have given in drying the following results:

	Pure clay.	⅓ clay, ⅔ sand.
Half of the water was evaporated at the end of...	46 hours.	30 hours.
Three quarters of the water was evaporated at the end of...............	78 "	52 "
Completely dried.. :.....	164 "	120 "

It is true that the first brick contained 22·7 per cent. of its weight of water, and the second 13·8 per cent.

The influence of the weakening of the clay was particularly observable at the end of the drying. The last traces of humidity are the most difficult to get out of clays that are very compact and plastic.

If we consider that the clays employed in this industry are mixtures of clay properly so called, or silicate of alumina, with some sand and carbonate of chalk, a description which is sufficiently precise from the point of view of the process we are at present concerned with, it will be seen that the clay and the carbonate of chalk retard the transmission of water, and the sand hastens it.

The carbonate of chalk it is true acts in a way to lighten the compactness of the clay, but as it itself absorbs a notable proportion of water, it follows that it does not facilitate drying. It even appears that its action was objectionable from this point of view, as is perceived in certain very calcareous plastic glazes which are extremely difficult to dry.

Thus the only means we possess of hastening the drying of a clay is to weaken it with sand, but it is necessary to state at once that this process cannot be universally applied.

Beyond the necessity for preserving a sufficient plasticity for the moulding, and which varies with the nature and the quality of the articles we wish to produce we are at once faced with another difficulty, viz., the lack of resistance and of cohesion in the moulded article.

If we mould the clay into the shape of bricks, and then attempt to pull them, we know that the resistance rapidly diminishes in proportion as more and more sand is added to the clayey paste.

Now, it is well known that in drying every piece of clay there are produced interior tensions which it is absolutely requisite that the piece must be able to resist without breaking. Therefore, while by weakening the clay too much we hasten its drying, we provoke for a manifest reason the ruptures we are particularly anxious to avoid. This fact explains the difficulty we meet with likewise in the drying of clay that is too thin.

In a piece of clay there will therefore be a degree of weakness which lends itself to the most rapid drying. Above that the transmission of the humidity takes place too slowly; below it the clay does not sufficiently resist the interior tensions.

This detailed examination into the method in which drying operates upon clayey pastes clearly demonstrates the error into which the majority of persons fall who only imperfectly understand the business, and who have sought to invent intensely hot drying rooms. They always forget the necessary element of time. Time is requisite for the internal humidity of the paste to get to the surface, and varies with the nature of the clay.

A drying room will work well with one clay, but will only produce disappointing failures with another. It is this elementary rule, so well known to all experienced workmen, which is continually neglected by inventors of more or less perfected systems, and it is its neglect which is the principal cause of their want of success.—*Journal of Ceramics.*

HOW TO MAKE A BREAST COLLAR, SINGLE HARNESS.

IN giving instruction as to the manner of making up, we think it best to confine ourselves to a good grade, one in which the leather work is well finished, but not in the finest style; by so doing we cover all the ground, leaving the extras to the time and patience of the workman. The first point to be considered is the selection of the leather, it cannot be too good. Select for all but the bridle, leather weighing about 18 pounds to the side; for the bridles a lighter leather, weighing about 14 pounds to the side, is preferable. Avoid cutting leather that must be split, as every split taken off weakens the leather; it is a well established fact that leather, the natural thickness of which is one-eighth of an inch, more or less, is stronger than a piece of like thickness that has been reduced from a heavier strap. If harness leather folds are used, they should be cut from a light side instead of the belly, as is often done. If enameled leather is preferred use medium weight, cut from a firm portion of the hide, and fill with a strip of kersey. Having selected a hide, straighten the back, then cut off the tail end to give a straight end six inches wide, from which measure off the length required for traces and reins; most harness makers cut the traces first, but if the side is long enough, and sufficiently free from defects to permit the traces and reins being cut side by side, cut the reins first if they are to be rounded; if not, cut the trace linings first; experiments have resulted in establishing the fact that the strip two inches wide next to the backbone is not as strong as the adjoining six inches, though more uniform. If the reins are cut first, cut the linings for the traces next and then the traces.

Having cut the traces and reins, straighten the back end of the butt; this being irregular, straighten so as to avoid waste; then measure off the length required for the breeching straps, and cut them from the back end of the side, the part of side here indicated being the strongest and stretching the least of any portion; then cut from the forward end layers for girths or other straps of that general character, and of the same width as that cut away for the breeching straps, the object being to keep the edge straight. Cut back bands next from the back end, and straighten the edge by cutting hip straps; or if the shoulder is thin, cut the straps for round reins, throat latch, crown pieces, etc.; the edge will again be straight. Commencing again at the back end proceed to cut linings for short straps, as this part of the hide is the weakest of any of the firm portions.

Having cut these straps to the depth of six or eight inches, cut up the front end into two layers for breeching, collar, belly bands, etc. Layers are too often cut from the weakest part of the hide; this is a great mistake, as the strain on the ends and points where the chapes are attached is greater than that on most other parts of the harness. When these are cut, the edge is once more straight, and the remaining straps, such as center cheek, martingale layer and point, and turnback can be cut in the order named; this completes all but the cheek pieces, short billets, docks and buckle chapes. The dock, if cut from the same hide, can be cut from the front end, as this part is softer and stretches more easily than the back end.

In giving these directions we have given a general plan, based upon the supposition that the side of leather selected is perfect. Should the shoulders be extra thin and soft, and the hip coarse and not well worked out, the cutter will be compelled to deviate from the order named; but he should adhere to the rotation as nearly as possible, the point to be kept in view being the selection of the strongest straps for such parts as receive the greatest amount of strain; the only arbitrary rule being to cut reins and traces from the center of the hide, in order to secure the requisite length. In cutting off all straps hold the knife perfectly square, so as not to nick into the next strap.

Having cut the straps, the next step is to fit them for working; if the leather has been well curried the proper course is to put the straps in cold water, and allow them to remain until wet through; the proper time can be determined by examination only, as the softest straps take the water the quickest; some harness makers decide by handling, others remove the straps from the water just as soon as grease begins to draw out and form a white coating on the surface of the leather. Let the manner of deciding when wet enough be what it may, be sure that the leather is wet through; if it is not, it will never get into a good condition for working. After removing the leather from the water hang it up so that all the straps are straight until it is surface dry; it will then be in a condition known as "sammied," that is moist and mellow, but not soft. The proper condition has so much to do with the successful working of the leather, its finish and durability, that it will not do to slight it in the least; when in good condition the straps should be wrapped into a damp cloth; in this way they can be kept without change for several hours. Before fitting up the leather, if inclined to be soft, it should be slicked down with a glass slicker on both sides, but much more on the under than on the black side.

The leather is now ready for the fitter, and he should go to work systematically, so that every thing is turned over to the stitcher in regular order. The first straps to be fitted are the rounds; these should be slicked out, and, if uneven, run through the splitter; next treat all the billets, center pieces, and cheeks in the same way, and apply a coat of tallow to the flesh side and lay them aside to dry; next skive the layers for the breeching, breast collar and neck pieces, slick them out and lay them aside to dry. Skive down the trace fillings or raise them to the required thickness, and trim the edges with a wide edge tool, then skive down the top and bottom, slick them out, raise the top and paste in the filling, being careful to use no more paste than is absolutely necessary, as it is liable to mould; moisten the top with a sponge and slick down with a bone slicker, then paste on the bottom, being careful to lay the straps, that is the top and bottom, heads and butts. In this way splitting is avoided, and the best results as to strength and stretch will be secured. In like manner, skive and paste up the tops and bottoms of the breeching straps; black, crease and punch holes for the buckles; skive off the bottoms to form the raise; paste down; treat the hip straps in the same way, slick with a bone slicker, and lay them aside to dry.

Fit up the shaft tugs, eight inches for a seven-eighths inch tug; the straps being cut one and one-eighth inch wide, one-eighth of an inch being taken off each edge of the part fitted up; fill in the other portion so as to take up the amount trimmed off, and give a uniform width to the strap; channel the inside so that the stitches will be buried below the surface; lay aside to dry.

Next fit up the dock, mark off for the chapes, trim to shape, skive down the edges quite thin, and bind them together; next fit up all the rounds by taking the edge off the full length to be rounded, and channel around the edges. Skive and line the winker brace, making the billet 4½ inches long; line the billet and allow the end of the lining to enter the round 1 inch, hammer up the rounds, have them stitched, then paste the billet down, and crease when dry. Prepare the breeching tugs, channel the front one 3½ inches, and the back one 4 inches; tack in the rings; next fit up the martingale, then the turnback; measure off two inches on the dock billets, and channel seven inches for the round, mark off the waves and cut out to pattern, hammer up the rounds, paste up the lining and lay away to dry.

After fitting up all other straps in like manner, cut the waves to all the layers, raise them in the block, rub them off with a rag, and crease with a double creaser; then go over them with a sinker; in like manner prepare the safes for breast collar, belly bands, etc.; paste them on the folds; when nearly dry double crease them; wet all the folds, hammer them down, and coat the inside with warm tallow, then put in the filler, paste on and tack the layers. As soon as each strap is dry enough it must be stitched; it can then be laid aside for finishing.

To do this commence with the rounds, dampen them with a sponge, and with a spoke shave on a leather plane; pull them through the rounder and rub them down with a wooden rounder and a little gum; dampen the docks, hammer the seams down over a wire, stuff with flaxseed, working in with a wire; trim the edge, black it, bend the dock to the required shape and nail it to a board to dry. Trim, black, and burnish the shaft tugs; burnish the edges, rub on a little tallow, and burnish with a bone slicker and a rag; all other straps must be rubbed down with a slicker on the under side, trimmed, blacked, and burnished.

Stitching cannot be done too carefully; the best wearing stitch for a light harness is 12 to the inch on traces, back bands, and holdbacks, and 14 stitches to the inch elsewhere, except on the rounds; these should be stitched about 8, though some prefer 6 stitches to the inch. Set a star stitch at the corner of each buckle, and see that the straps are drawn close to the buckle bar. In the final finish use tallow and a rag, and rub until a good polish is secured.

LENGTHS AND WIDTHS FOR CUTTINGS.

Part.	Length, inches.	Width, inches.
BRIDLE.		
Crown piece........................	24	1⅛
Billets	6	½
Cheeks	29	½
Throat latch........................	28	⅜
Front made up, between loops..	12	¾
Winkers........................	4⅛	4¾
Winker brace........................	13	1
Billet	4½	1½
Split round........................	7½	—
Checks........................	26	¾
Billets........................	9	¾
Center check........................	60	⅝
BREAST COLLAR.		
Body, layer........................	42	⅞
At ends	—	1
Neck strap........................	38	¾
At ends........................	—	⅝
Tugs........................	7	⅝
Traces........................	80	1
GIG SADDLE.		
Tree........................	3½	—
Flaps........................	20	3¼
Points........................	9	¾
Jockeys	4	3½
Back bands.	22	1
Shaft tugs.	21	1
Belly band........................	22	¾
Shaft girth........................	27	¾
Billets	22	¾
Martingale........................	40	1
Bottom........................	20	¾
BREECHING.		
Body layer........................	44	⅞
Hip strap	42	½
Breeching tugs, round........................	12	⅞
Buckle chapes	9	½
Breeching straps........................	48	1
Turnback........................	44	⅝
Body........................	—	1¼
Split........................	8	⅜
Crupper dock........................	16½	3½
FOLDS.		
Breast collar........................	34	3¼
Neck........................	24	2¾
Breeching	35	3¼
Belly band........................	17	2¾
Shaft girth........................	27	2¾
Martingale........................	34	2½

MOUNTINGS.

2 1⅜ or ½ in. terrets.	2 ⅞ in. rein buckles.
1 bolt hook.	2 1¼ in. martingale rings.
2 1 in. trace buckles	2 1¼ in. breeching rings.
2 1 in. shaft tug buckles.	4 ⅞ in. rings.
4 ¾ in. roller buckles.	2 ⅝ in. rings.
2 1 in. roller buckles.	2 gag swivels.
9 ½ in. buckles.	4 saddle nails.
5 ⅝ in. buckles.	2 rosettes.
3 ¾ in. buckles.	1 half cheek bit.

—*Harness.*

THE PATH OF THE POINT OF CONTACT OF THE TEETH OF GEAR WHEELS.

By W. F. DURAND.

THE following proposition is not usually given in treatises on kinematics and other works relating to the theory of the teeth of gear wheels. While perhaps not of great practical importance, it is not without interest as being the general proposition of which a special case is usually given in such works.

The problem arises as follows:

Given two pitch circles A B and C D as the centroids, and a third curve E F. Suppose C D fixed, and A B to roll upon it. Let also E F roll upon A B while the latter rolls on C D in such way that its point of contact with A B is coincident with the point of contact of A B with C D. Under such conditions the curve E F may be said to roll upon both A B and C D.

Let P be any point in the plane of E F and moving with it. Then P relative to A B will trace a curve P T, and relative to C D a curve P S.

These curves, as shown by the propositions of kinematics, may be used as profiles for gear teeth, and will fulfill the required conditions for furnishing a constant velocity ratio between A B and C D.

Let it now be required to find the path of the point of contact of the teeth during the action of the curves P S and P T, which will in general touch in one point only at a time.

Suppose E F rolled to the left from the given position upon A B and C D respectively until H becomes the point of contact. Let P S and P T be the curves thus generated by the use of this arc O H. Next let E F be *slipped* around, revolving to the left, always maintaining its point of tangency at O, until H comes to O, the point of contact of the pitch circles. E F as a whole will then take some new position E′ F′, and the point O of the curve E F will come to some position G, while P will come to some position Q. From this position let E′ F′ roll to the right, first on A B, then on C D, stopping in each case the motion when the point G comes again into contact with the pitch circles. Two curves Q V and Q U will thus be traced in contact at Q. These curves must be identical with S P and T P, since the same arc O H or O G rolling on the same base circles has been used in each case.

Now since S P and Q V are identical and similarly situated with reference to C D, it follows that S P can be revolved into the position Q V. Also for the same reason T P can be revolved into the position Q U. Suppose now C D with its profile S P to revolve until S P comes to the position Q V. Let this be the driver. Then T P will be forced into a new position, which we may designate by T′ P′, not shown in the diagram. We now wish to show that this T′ P′ must be identical and coincident with Q U.

To this end we note that T′P′ and Q U must each fulfill the following conditions:

1. They must be identical with T P and similarly situated with reference to A B.

2. They must be in contact with Q V.

These two conditions cannot be fulfilled for each curve unless they coincide throughout.

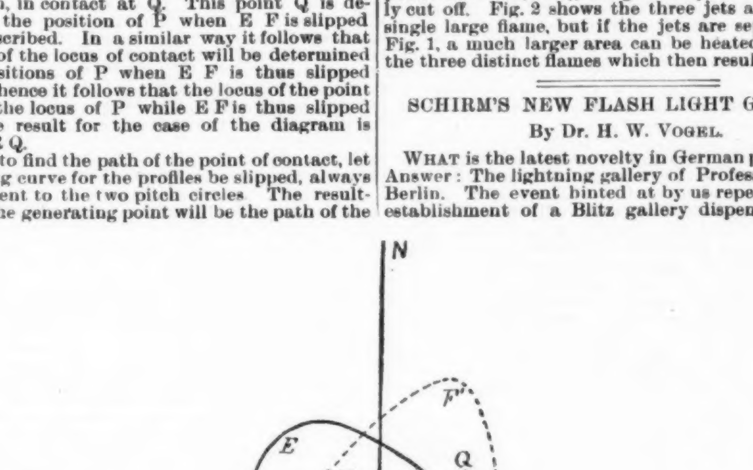
It follows therefore that the two profiles as specified, one acting on the other as described, will be, for the given position, in contact at Q. This point Q is determined by the position of P when E F is slipped around as described. In a similar way it follows that other points of the locus of contact will be determined by other positions of P when E F is thus slipped around, and hence it follows that the locus of the point of contact is the locus of P while E F is thus slipped around. The result for the case of the diagram is shown at P R Q.

Therefore, to find the path of the point of contact, let the generating curve for the profiles be slipped, always keeping tangent to the two pitch circles. The resulting path of the generating point will be the path of the point of contact for tooth profiles generated in the usual way.

In the above brief statement the direction and limitations of the slipping are not specified. They are easily seen from the diagram.

In the especial case used in practice for epicycloidal teeth, the curve E F becomes a circle, and the point P is located on its circumference. The initial position of P being at O, the center of the generating circle is then of course on the normal O N.

From this position slipping the circle around as described above, the point P will describe an arc of its own circle. The locus of the point of contact becomes then, in this case, an arc of the generating circle, the circle being in its position of common tangency with the two pitch circles. The results for this special case are usually given in text books on the subject, though frequently without special proof. From the preceding it appears that in general the locus of the point of contact is *not* an arc of the generating curve, but a totally different curve, derived from it in the way described.



THE PATH OF THE POINT OF CONTACT OF THE TEETH OF GEAR WHEELS.

NOTE ON A NEW TRIPLE BUNSEN BURNER.

By F. W. BRANSON.

MR. F. W. BRANSON, of Leeds, exhibited a high or low power triple Bunsen burner, a drawing of which is here given:

Fig. 1. Fig. 2.

The above combines in one piece of apparatus several gas burners, and is simple in construction and not liable to derangement. Either one, two, or three Bunsen or luminous flames may be used, and the air or gas supply of either jet can be regulated independently or entirely cut off.

The air regulators are arranged in the usual way. The gas supply is controlled by altering the position of the jets. If arranged as in Figs. 1 or 2, the gas supply is at full. If, however, either jet be rotated in the opposite direction, the gas is gradually reduced and finally cut off. Fig. 2 shows the three jets arranged for a single large flame, but if the jets are separated as in Fig. 1, a much larger area can be heated by means of the three distinct flames which then result.

SCHIRM'S NEW FLASH LIGHT GALLERY.

By Dr. H. W. VOGEL.

WHAT is the latest novelty in German photography? Answer: The lightning gallery of Professor Schirm in Berlin. The event hinted at by us repeatedly of the establishment of a Blitz gallery dispensing entirely with daylight has at last become a fact, and immense progress in photography has been made thereby, which cannot be estimated highly enough, particularly during the present dark days of winter and the holiday season. The instantaneous Blitz gallery has been open since December 1, under the modest title of "Gallery for Artistic Portraits," Potsdam Str. 20. This Blitz light is employed not only for taking negatives, but also for the production of prints. This is a still greater progress, the negatives being of not much advantage if the cloudy winter days make printing an impossibility.

Our advice to apply the Blitz light, if not rejected, at least met with indifferent consideration, and thousands of reasons were brought against it. We have here an artist, one of the best in his profession, and at the same time a clever amateur of photography, and he accomplishes what professionals would not risk to touch, and in such a masterly manner that every one who has seen his establishment must be at once convinced.

It was no easy matter for Mr. C. C. Schirm to train his operators for this entirely new mode of photography. He has succeeded because he is not easily disconcerted.

Schirm's gallery is one of the usual elegant dwellings on the first floor, with a small hall and ante-chamber serving as a reception room, two rooms which are arranged as Blitz galleries, and a large passage room with one window, into which daylight penetrates only from one corner, and which bears the name of "Berlin room," as an authorized Berlin peculiarity.

This ordinarily partly dark Berlin room forms the large Blitz gallery for groups. Each of these rooms has, so to speak, a firmament of Blitz lamps.

Schirm's lightning apparatus is known. He works, as Piffard has done before him, by blowing magnesium powder through the flame with an apparatus; but while Piffard applies large quantities—more than one gramme—he proves that a minimum quantity, 0·03 gramme (1-20 grain), is sufficient for one sitting, and that more is rather injurious than useful. This apparatus is excellent for single pictures, but not sufficient for larger views in grand style. Here it is oftentimes necessary to apply 7, 8, and even 15 to 20 lamps, and to ignite these simultaneously, the latter being of great importance. It is also important not to let the lamps be too near to the subject.

In Schirm's gallery they move therefore on rails about four meters from the floor and near to the ceiling. Each lamp consists of a Bunsen flame, through which the magnesium is blown, and an illuminating flame, which serves for studying the light effect of the lamp. Some of the lamps are ignited in front of the subject, others from the side. The arrangement is such that the ceiling contains a system of rails, which might remind one of the game called "Mill." An exterior square of rails is placed round the four walls, and in the small room an additional inner square of about half the size. In the Berlin room, intended for groups, is a third and still smaller one. Upon these rails the lamps can be moved at will. Each lamp carries gas tubing and a tube for blowing, which are connected with the main gas pipe and also with the bellows.

This rather complicated system of tubing swinging from the ceiling leaves a peculiar, still not disturbing, impression at first sight. In the small room I counted fourteen on the exterior square, eight on the inner one. In the large room there were sixteen lamps outside. Each lamp (illuminating burner as well as Bunsen burner) had a cock with a long lever, which from the floor could be opened and closed with a pole hook. Above each lamp burns continually a small igniting flame, from which the gas will ignite by opening the cock. The Bunsen burner is in connection with a small magnesium powder reservoir, which, on being closed, after ignition of the powder, will drop a new, small quantity of 1½ centigramme of magnesium into the blowpipe for the next view. A larger quantity of magnesium has not been found effective; if more light is required, more lamps should be used.

At a single sitting we saw nine lamps in activity—four from the side, four in front, and one from the other side almost behind the sitter. Most of the negatives are taken on old, extra blue sensitive plates, the magnesium light containing mostly blue rays. A mechanical electrical arrangement is used for the exposure, which, after the subject has been posed, opens first the flap on the objective, and immediately afterward sets the blowing apparatus to work, which blows the magnesium powder through the flame, after which it closes again the objective flap, all by electrical movement.

The whole system is so neat and well executed that we cannot sufficiently praise the inventor.

The blow light itself is not instantaneous, and lasts about one-half second, but the time of the objective shutter is only about one-tenth second, so that the exposure can be considered instantaneous. It is remarkable that all brands of dry plates have not proved equally good and effective. The sensitive Beernaert plates cannot be used at all. Voigtlander's Euryscope, Series III, second diaphragm, was used as an objective. It remains a fact that a well exposed negative was obtained. It may have had a pretty strong top light character, according to the judgment of some; but that pictures can be obtained of faultless illumination is proved by Delden's magnesium Blitz pictures (*Photographische Mittheilungen*, 1889, May 2). It is also evident that in such a room one is enabled to utilize every place, under the window, the piano, the stove, near the door or in any corner, for posing the subject, so that more change in the artistic arrangement is possible. The decoration of the whole room should of course be selected and graduated photographically, and if this has not been done, it is an error which can easily be remedied.

The Blitz printing process is also interesting. This is executed on bromide paper. To prove that paper copies could be obtained at once, Professor Schirm pressed a piece of paper upon a gelatine negative, quite wet, and washed only for ten minutes, placed this upon a table arranged with a measure (rule) opposite a vertical ground glass at a distance of about 120 cm., and ignited behind it, with his military Blitz lamp—which is commonly used for signaling—a flash of 1½ centigrammes of magnesium powder. This was sufficient to obtain, with eikonogen development, a well exposed print. It is peculiar how the character of the pictures and their tone changed by placing the negative nearer to the light or further off. Those near by appeared browner and softer.

Ordinarily the prints are made after the negative is thoroughly dry and has been retouched, and a dozen cartes-de-visite can easily be printed with one flash. The tone of the prints I saw was perhaps a little too cold, but warmer tones can easily be obtained by a change in the lighting and development. Dr. Just's

book, "Guide for Positive Developing Processes," gives the desired information. By the powerful action of the Blitz light it is shown that two flashes were sufficient to obtain a very intense positive from a drawing on bromide paper. Prints from these flash negatives can, of course, also be made by any of the other processes, so that in this respect no objection can be made to them.

Mr. Van Delden is fitting up another Blitz gallery in Breslau, but Mr. Schirm deserves the merit of having been the first to introduce this new kind of Blitz gallery. This is certainly a new step forward in photography—emancipation from daylight and emancipation from time; and I am convinced that it will have considerable influence on the progress of our beautiful art.—*Anthony's Bulletin.*

THE FORMATION OF OZONE BY ELECTRIC DISCHARGES.

Among the multiple utilizations of electric energy in chemistry, there is one that presents a great interest from the standpoint of industrial applications, and that is the production of ozone through latent discharges, or "effluvia." Such preparation has been the object of a large number of purely scientific researches and also of many industrial tentatives. As an evidence of this, it is only necessary to consult the list of patents of the last fifteen years.

A recent work of Messrs. Bichat & Guntz upon this subject brings it again into prominence. The interesting researches of these gentlemen give the conditions (still obscure) of the formation of ozone, and, later on, will doubtless permit of realizing apparatus for the production of it on a large scale, that is to say, of rendering the preparation of it industrial. Van Marum, as long ago as 1783, observed that electric discharges communicated odoriferous properties to the air. Up to about 1840, the explanation of this phenomenon was abandoned. Schonbein recognized the nature of the odorous gas produced, and named it ozone. Marignac, De la Rive, Fremy, and Becquerel have since demonstrated that ozone is due to an allotropic modification of oxygen, resulting from a condensation. Andrews and Tait, De Babo, and Soret afterward established its degree of condensation, and, finally, in recent years, Berthelot has shown that ozone is formed with absorption of heat, and, consequently, that it is an explosive product or one of endothermic formation.

$$3O = O^3 - 14{,}800 \text{ small calories.}$$

It, therefore, can form only by obtaining the aid of a foreign energy.

Different processes of chemical order permit of obtaining ozone along with products disengaging heat. It is well known, in fact, that phosphorus and some other bodies, in oxidizing, permit of the conversion of the surrounding oxygen into ozone. So, too, every time that oxygen is disengaged, cold, from a strongly exothermic reaction, it is more or less ozonized. This is what happens, for example, in the action of sulphuric acid upon permanganate of potassium or upon binoxide of barium.

The energy necessary for the conversion is perhaps borrowed from a foreign source, either in the form of electricity or in that of heat. Thus, Messrs. Troost and Hautefeuille have produced ozone through the action of a temperature of 1,400° upon oxygen, by using the ingenious arrangement of the hot and cold tube due to Henri Sainte-Claire Deville. In the electrolysis of water, the oxygen disengaged is ozonized. But of all the processes used for preparing ozone, the one now almost solely employed is the latent discharge in oxygen. It has been found that the brilliant discharge effects the transformation of oxygen but partially, and that, on the contrary, the latent discharge or effluvium gives very much better results. A large number of arrangements have, therefore, been devised to produce such effluvium. All may be reduced to a single type, which consists essentially of two conductors of a certain length placed parallel and separated by a plate of glass and the stratum of oxygen to be transformed. The glass and gas form together the dielectric through which the discharge may be effected. The glass, moreover, may be replaced by other materials of different specific inductive powers. Among the arrangements employed, that of Babo, modified by Houzeau, is the oldest. The discharge takes place therein between two platinum wires, one of which (*a*, Fig. 1), of quite large diameter, is placed in the direction of the axis of a narrow glass tube from 1 to 2 mm. in thickness and 40 cm. in length. The other wire, *b*, of small diameter, is wound around the same tube. In order to obtain ozonized oxygen, a slow current of oxygen is passed into the tube, and, at the same time, the two ends of the wire are put in communication with the two poles of a Ruhmkorff coil.

Another apparatus, due to Siemens, consists of a glass tube closed at one extremity and cemented in the interior of another and larger tube, which is provided at its two extremities with two tubes of small diameter designed for the passage of the gas into the annular space formed by the two tubes. The lower tube contains a conductor formed of tinfoil affixed to the inner surface. The outer tube is covered with tinfoil externally. It will be seen that in this apparatus the discharges will have to traverse the two surfaces of glass and the volume of the gas.

Ruhmkorff constructed an apparatus formed of parallel plates of glass placed very near each other, provided with a sheet of tin at their upper part, and communicating alternately, in pairs, with two metallic buttons that were connected with the poles of a bobbin. In superposing one upon the other, at the same distance, a large number of these plates inclosed in a box with two tubulures, the effluvium can be produced over a very wide surface.

In all these apparatus the conductors employed may vary in nature. Thus, after platinum and tin, there have been tried copper, mercury, pulverized retort coke, plumbago (Boillot apparatus), chloride of antimony dissolved in hydrochloric acid, concentrated sulphuric acid, and acidulated water. Siemens' arrangement, in which liquids are used as conductors, has given rise to the apparatus of D'Arnoult, Thenard, and Berthelot.

Thenard arranges three concentric tubes properly joined so as to present three spaces, one of them cylindrical and the two others annular, and separated by glass partitions, as shown in the figure. The central tube, which is closed at one end, contains the conducting liquid that serves as an internal armature. The external annular space is filled with the same liquid and forms the external armature. The liquid conductor is chloride of antimony dissolved in hydrochloric or concentrated sulphuric acid. It communicates by two platinum wires with the poles of a bobbin. The intermediate annular space serves for the passage of the oxygen. The apparatus is arranged horizontally. It has the advantage over the preceding of being transparent and of permitting of the intensity and light of the effluvium being observed at every instant.

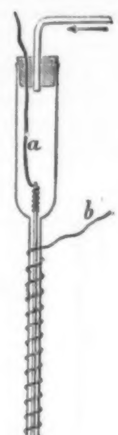


Fig. 1.

The Berthelot apparatus, to which preference is now given in laboratories, consists (Fig. 3) of a tube, *c*, of thin glass, 30 mm. in diameter, and from 30 to 35 cm. in length, and closed at the lower part. To it are affixed two small eduction tubes, one of them, *b*, at the lower part, and the other, *c*, near the top. In the axis of this tube is introduced a tube, *d*, closed at one end, 25 or 28 mm. in diameter, and fixed a little above the upper eduction tube. Sometimes these two tubes are connected by grinding with emery. It is necessary that the apparatus shall be well centered, that is to say, that the distance between the two surfaces of glass shall be everywhere the same.

It is possible, moreover, to verify the parallelism of the tubes by a production of the effluvium, which should have everywhere the same brightness. These two tubes thus connected are suspended by means of a cork in a large test glass filled with water acidulated to a tenth with sulphuric acid. The internal central tube is likewise filled with acidulated water. The two conducting liquids communicate with the poles of a bobbin through two platinum wires. The gas circulates in the annular space, which it enters through the lower tubulure, *b*, and from which it escapes through the upper tubulure, *a*. It is at the extremity of this eduction tube that the ozonized gas is collected. It is necessary to cover the parts of the tubes, *d* and *c*, that enter the air with lac varnish, in order to prevent sparks externally.

These apparatus are constructed by Mr. Alvergniat, whose skill as a glass worker is known to all scientists. The distance included between the two concentric tubes may vary from 1 to 4 mm. The distance of from 1 to 2 mm. given above does very well for the medium sized bobbins used in laboratories.

The appearance of the discharge in gases must, *a priori*, necessarily vary with the differences of potential of the conductors, the reciprocal distance of the latter, and the nature of the gases experimented with. We can easily show, in the clearest manner, the three very distinct forms of this discharge with Berthelot's ozonizing tubes (Fig. 4). These experiments are made every year during the general chemical lessons of the Faculty of Sciences of Paris. Here are shown, in the first place successively and then simultaneously, the discharge, under the form of sparks, of rain of fire or egret, and of effluvium. The current of a powerful Ruhmkorff coil is employed.

The spark is obtained in an ozonizer filled with chloride at the ordinary pressure, and closed by means of a lamp. It moves in the tube in all directions, often exhibiting the form of webs of fire isolated from each other.

The rain of fire is obtained in a particularly beautiful and well defined form with an ozonizer like the first, but filled with very dry fluoride of silicium. It presents the aspect of a luminous sheet formed of small brilliant globules always in motion—a true rain of fire of a greenish yellow in darkness. This phenomenon would be obtained again in nitrogen and hydrogen at the ordinary pressure.

The effluvium is observed in the same apparatus filled with oxygen, but, in order to have the beautiful violet light, tremulous and sensibly uniform without globules, it is necessary to fill the Berthelot tube with

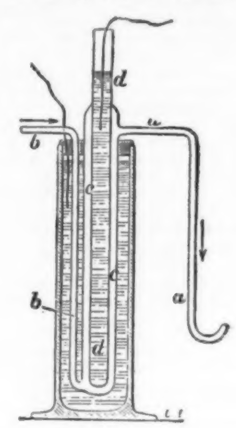


Fig. 3.

nitrogen at a pressure of 50 mm. In this rarefied nitrogen the phenomenon is very well marked. The three tubes can also be put simultaneously on the same circuit of a strong induction coil, and the three aspects of the discharge be observed at the same time.

From a chemical point of view, the effects obtained by these three forms are very different. Thus, the spark instantaneously brings about the combination of the hydrogen with the oxygen, furnishing the work preliminary to the reaction, while the rain of fire effects this combination only in the long run. On the contrary, the effluvium exerts no action upon the mixture of hydrogen and oxygen.

The researches of Messrs. Hautefeuille and Chappuis have shown that it is the rain of fire that gives the best results in ozonization with the Berthelot apparatus; but that, in order to obtain this rain in oxygen, it is necessary to mix it with gases, such as nitrogen, hydrogen, or fluoride of silicium, or else diminish the pressure. Practically, when we wish to make ozone, it is necessary to so manage as to have a very luminous effluvium, to be in darkness in order to observe it, and to try to obtain a maximum of coloration. If a bobbin of medium size be arranged with four or five Bunsen or bichromate elements, pretty good results are obtained. Other conditions also must be fulfilled. The external temperature very notably influences the rendering. By surrounding the apparatus with a refrigerant mixture, we increase the proportion of ozone in the oxygen that traverses the apparatus; at −23° we obtain 21·4 per cent. of ozone from the oxygen, while at 20° we get but 10·6 per cent. The velocity of circulation of the gas in the annular space ought not to be too great, as a certain quantity escapes the action of the effluvium in this case. Neither should it be too small, as the ozone formed by a first effluvium is destroyed by the passage of succeeding effluvia. A velocity of one bubble per second gives good results.

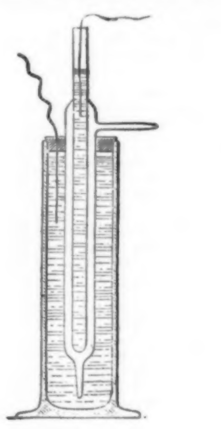


Fig. 4.

It is important, too, to employ dry oxygen, and to this effect it is washed in flasks of sulphuric acid; but what is especially necessary is oxygen free from chlorine. Now, oxygen prepared with chlorate of potassa always contains chlorine, from which it can be freed by washing it in a dilute solution of potassa, at the moment of its preparation.

Upon the whole, from this rapid review of the practical methods adapted for the preparation of ozone, it will be seen that there result thus far no data, either

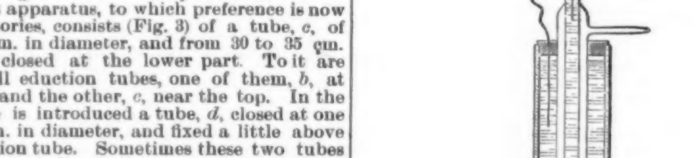


Fig. 2.

as regards the theory of the action of the effluvia or the electric quantities that enter into play in the ozonization of a determinate quantity of oxygen. Ozonizing apparatus have always been constructed empirically with the object of obtaining a maximum of effect, account being taken of the influence of the temperature, of the pressure, and of the presence of foreign gases.

The electric conditions of ozonization remained unknown. It was well known that all the modes of disruptive discharge produced a transformation, to a greater or less degree partial, but the action of the discharge itself was not settled upon. Was the phenomenon due to an electrification, or did it not rather result from the heat produced by the discharge? It is this important question that became the object of Messrs. Bichat and Guntz's researches that we are going to cite in detail.

It became necessary to look for conditions under which measurements were possible. In the Berthelot apparatus the discharges take place through two dielectrics—oxygen and glass. Upon suppressing the glass, the apparatus is reduced to two conductors between which a current of oxygen circulates. Effluvia are obtained every time that a conductor in connection with the earth is brought into the presence of another conductor, having at one or more points extremely small radii of curvature, as a point, a wire of small diameter, that is to say, when loss is possible. The use of a wire is preferable, as it can always be identically reproduced.

Messrs. Bichat and Guntz's experimental apparatus consists of a fine platinum wire, one-tenth mm. in diameter, stretched out in the direction of the axis of a platinum cylinder about 4 cm. in diameter. The wire is much shorter than the cylinder, and is soldered at the two extremities to platinum wires of sufficient diameter to prevent the loss of electricity. The system of the two conductors is placed in a glass tube closed at the two ends and provided on each side with a tube carrying a glass cock for the circulation of the gas in the apparatus. The fine platinum wire is put in communication with one of the poles of a Holtz machine and with an absolute electrometer. A Mascart "trop-plein" permits of keeping the wire at a constant potential. The cylinder is connected with the earth through the intermedium of a galvanometer.

Through an ingenious arrangement, the oxygen is made to pass with a constant velocity (1 liter in 13 minutes) for 25 minutes, and the ozonized oxygen is collected under a volume known from a titrated solution of arsenious acid. Upon putting the central wire successively in connection with the positive and negative poles of the Holtz machine, and so arranging things that the discharge indicated by the galvanometer shall be the same in both cases, the following results have been obtained:

	Positive Effluvium.		Negative Effluvium.	
	Potential C. G. S.	Ozone Produced (Mean of 5 Exper.)	Potential C. G. S.	Ozone Produced (Mean of 5 Exper.)
Discharge 20	V = 14·6	0·2 mg.	V = 12·6	2·05 mg.

It will be seen that, in order to obtain the same discharge, the potential must be much greater in the case in which the electrification of the wire is positive, and yet the negative effluvium for a same discharge furnishes a quantity of ozone ten times greater than the positive. Houzeau, who endeavored to learn precisely the conditions of the formation of ozone, had already obtained this result:

His internal electrode being negative, he had, in one experiment, 0·695 mg. of ozone per liter, and, when it was positive, 0·124 mg. The apparatus may be modified, and the fine wire be replaced by a point placed opposite a disk. With this arrangement there has been obtained 0·8 mg., the point being positive, and 1·15 mg. when it was negative. The potential was 18·5 C. G. S. units in the first case and 16·7 in the second.

This difference of rendering with the sign is not perceptible for small distances of the two conductors—a few millimeters for example; the quantities of ozone are then equal. But if the distance increases, such difference increases notably. The production of ozone can be attributed either to the elevation of the temperature produced by the discharge or to the passage of the electricity. If we admit the first hypothesis, we can understand why the rendering is greater with the negative discharge, which is more brilliant, and, consequently, warmer than the positive.

Mr. Semmola has shown that the temperature of a point, arranged in a thermo-electric clamp, varies with the sign of the electricity that it allows to escape, and that such temperature is greater for the negative electricity.

In the second hypothesis, there ought to be a proportionality between the quantity of ozone formed and the quantity of electricity that passes. Now, experiments show that there is nothing of the kind. There is no simple relation; Faraday's law is not applicable. It is the thermic hypothesis, therefore, that we shall admit, and we shall have all the elements for a quantitative study of the phenomenon of the conversion of oxygen into ozone.

We can, in fact, calculate the electric energy employed and the quantity of heat corresponding to the formation of a certain weight of ozone; and, in order to verify the calculation, we can even measure directly, by the water calorimeter, the heat given up to the oxygen by the passage of the effluvium. To this effect, we arrange in the center of a platinum bottle an insulated point of the same metal; two tubes permit of the circulation of oxygen in the bottle, and are so arranged that the gas can take the temperature of the calorimeter before making its exit. The whole is inclosed in the calorimetric circumference. The potential of the point is measured with the absolute galvanometer, and the discharge with a galvanometer placed on the circuit. Three experiments were made, and gave for the energy brought into play, expressed in small calories, the number of 169·95 cal. The portion of heat utilized for the production of the ozone is but 0·64 cal. The heating of the calorimeter found by the experiment corresponds to 169·3 cal. It will be seen that the concordance between the calculation and experiment is complete. It will also be seen that the ratio between the quantity of heat absorbed by the production of ozone and the energy brought into play is extremely feeble—$\frac{64}{16995}$, that is to say, less than $\frac{1}{265}$. The rendering is, therefore, very small with Messrs. Bichat and Guntz's apparatus of study, and if we propose to produce ozone, we shall employ the apparatus above described, and particularly M. Berthelot's, which the learned professors of Nancy have studied. The Berthelot ozonizer, placed in darkness, is connected with an exciter and a Holtz machine. It is then found that it is illuminated every time that an electric spark appears, and that this illumination varies in intensity with the resistance interposed in the circuit. If the resistance increases, the brilliancy diminishes, and if the ozone be tested for quantity, in causing the resistance to vary, it will be found that, for the same explosive distance, the weight formed diminishes in measure as the resistance increases.

Even if the difference of potential is large between the conductors, there is no more ozone formed, if there is no more light. It is, therefore, the luminous discharge that raises the temperature abruptly at certain points. The gas, moreover, is as abruptly cooled by its contact with the rest of the gaseous mass in circulation. In other words, the oxygen is found in the same conditions as in the Deville hot and cold tube. Troost and Hautefeuille, moreover, have shown that oxygen heated to 1,400 deg. and immediately cooled is converted into ozone, as has been stated above. The following experiments prove this manner of the charge's acting:

The ozoning tube is connected with a Holtz machine, the circuit of which includes an exciter. The distance of the balls of the exciter is made to vary, and the tube is examined. Under the conditions of the experiment, the illumination becomes visible only for an explosive distance of 1·75 mm., and, as we have already seen, there is no ozone formed before the illumination. For explosive distances of 1 and 1·5 mm. we obtain neither light nor ozone.

As well known, the discharge gives out a quantity of electricity equal to C V; C being the capacity of the apparatus, and V the difference of potential. If the quantity depends upon the discharge, according to Faraday's law, the weight formed will be proportional to V. Now we find:

Explosive Distance.	Potential C. G. S.	Ozone Produced per Discharge in $\frac{1}{100000}$ mg.
3 cent.	38·2	115
6 "	64·9	186
9 "	81·6	279
12 "	91·3	354
13 "	101·8	541

There is no proportionality. It is probable that if we could collect all the ozone, without a part being decomposed, the quantity would vary as to the energy, that is to say, would be proportional to V^2, experiment having shown, as we shall soon see, that at $-20°$ the rendering in ozone is near unity.

We can account for the necessity of having an explosive distance of at least 1·75 mm. in order to obtain the latent discharge in the Berthelot apparatus. In order that a disruptive discharge shall take place between two conductors, there must exist between the latter a determinate difference of potential for a dielectric of a given nature. Now, the dielectric in the ozonizing tube consists of glass and oxygen—two vitreous surfaces separated by a thin stratum of gas. Let us grant that, in order to obtain a discharge between two points opposite the surfaces of the glass, the differences of potential be the same as if they belonged to the two conductors, and that V be such difference. Let V_1 be the difference of potential of the armatures, and e the thickness of the glass corresponding to a thickness of oxygen $\frac{e}{k}$; k being the specific inductive power of the glass and e_1 the thickness of the stratum of oxygen. The thickness of the condenser thus formed will be:

$$e_1 + \frac{e}{k} = e_2$$

And we shall have:

$$\frac{V_1}{e_2} = \frac{V}{e_1}$$

Whence:

$$V_1 = \frac{e_1 + \frac{e}{k}}{e_1} V \qquad (1)$$

The difference, V, necessary for the production of a spark between two conductors distant by e has been determined by means of experiments made in the air by Mr. Baille. Messrs. Bichat and Guntz have verified the fact that in oxygen and nitrogen the results are sensibly the same, and, consequently, that it is the same for air and oxygen. We shall be able, then, to use the figures found by Mr. Baille. We know, moreover, the specific inductive power of the glass; and the thicknesses, e and e_1, are measurable. We shall calculate V, and look for the corresponding explosive distance in Mr. Baille's tables. There has been found, as explosive distance for the difference of potential calculated in the ozonizing tube, the value of 1·75 mm., on taking 6 for the specific inductive power of the glass; this is the number found by experiment. Moreover, the accuracy of the preceding relation (1) has been verified. For this, two large plates are arranged horizontally and separated by insulating pieces of ebonite. The external faces of these plates are covered with tin foil, and the latter is connected with an exciter provided with a micrometer screw and put in communication with the poles of a Holtz machine. The poles of the exciter are separated until the rain of fire is seen to appear between the plates. The distance of the balls of the exciter is measured and the value V_1 is deduced therefrom. This same value is calculated with the formula (1). We find the same figure. There would here be a method for determining the specific inductive powers. We draw, in fact, from equation (1):

$$k = \frac{V}{V_1 - V} \frac{e}{e_1}$$

The specific inductive power of the gases would be easily and accurately measured by this rain of fire method. If we knew the electric capacity of the tube, now that we know the difference of potential, we might calculate the energy brought into play as in the experimental apparatus described above. Now, we can measure such capacity, and, for this purpose, Messrs. Bichat and Guntz have constructed a condenser formed of two concentric cylinders, one of which is fixed and the other movable parallelly with the common axis, thus constituting an apparatus whose capacity varies by known quantities. Let us suppose, in fact, that for a given position of the two cylinders, the capacity of the condenser formed be x; then, if we push the movable cylinder in by a length, a, the capacity will increase by the value of the capacity of an indefinite cylindrical condenser of length a, that is to say, by $\frac{1}{2} \frac{a}{L \frac{R}{r}}$ the radii of the two cylinders being designated by R and r. That being the case, we compare the capacity, x, of the cylindrical condenser with the capacity, y, of the ozonizing tube. We find a relation, m:

$$\frac{x}{y} = m \qquad (2)$$

We increase the capacity of x by a known quantity, C, by pushing the tube in by a length, a:

$$C = \frac{1}{2} \frac{a}{L \frac{R}{r}}$$

We compare again with the ozonizing tube, and find a relation n:

$$\frac{x + C}{y} = n \qquad (3)$$

The two equations (2) and (3) determine x and y. There has been obtained for the capacity of the Berthelot tube employed the value of 0·37 m. The difference of potential, V, corresponded to an explosive distance of 9 mm. For such distance Baille's tables give

$$V^2 = 6{,}658{\cdot}5.$$

The energy brought into play at each discharge is, therefore,

$$\frac{1}{2} C V^2 = \frac{1}{2} \times 37 \times 6{,}658{\cdot}5 = 123{\cdot}182 \text{ ergs},$$

which corresponds to

$$\frac{123{\cdot}182}{425 \times 10^5} = 0{\cdot}00289 \text{ small calories.}$$

Into the apparatus thus defined there was passed a thousand discharges, care being taken to keep it at $-20°$ and to cause oxygen to circulate in it very rapidly in order to remove the ozone formed by the destructive action of the following sparks. The ozone was collected in the titrated arsenious liquid, and in two successive experiments there were obtained by the thousand discharges 4·5 mg. and 4·8 mg. For 24 grammes of ozone O^3 there is an absorption of 14,800 small calories; for 4·5 mg. there is an absorption of 2·7 c.; and for 4·8 m., there is an absorption of 2·88 c. Now, the energy calculated for a thousand discharges was 2·89 c.; there was a utilization of 2·7 c. in one experiment, and 2·88 c. in another. The rendering at 20° is, therefore, almost maximum for a given potential comprised between $\frac{270}{289}$ and $\frac{288}{289}$, that is to say, bordering on unity.

These experiments have explained the conditions of the formation of ozone by the latent discharge or effluvium. Their interpretation will assure of the realization of apparatus of large rendering utilizing in the best possible manner the energy furnished. In this regard the Berthelot apparatus is nearly perfect, provided always that it be cooled and that the gas be passed into it very rapidly.—*La Lumiere Electrique.*

THE ELECTRIC DECOMPOSITION OF CHLORIDES IN SOLUTION.

Many years ago the patent records told us how we might prepare caustic soda and chlorine from a solution of common salt by passing a current of electricity through it; but those were the days of primary batteries, when the cost of the electric current put all such decompositions out of the question. The improvements in dynamos during the last two decades have entirely altered the situation, though, in our opinion, the matter is still unsolved—yet the problem is becoming nearer of solution day by day.

There are three steps by which practical electrolysis must be effected; the first is an economical supply of power; the second, an economical transformation of that power into electricity; and, thirdly, the discovery of practical methods of decomposition. The first step will probably be solved by the Hargreaves thermomotor; the second may be regarded as practically solved, though students of electrolysis on the large scale will possibly prefer to blunder along making their own discoveries than to accept the results of contemporary workers.

It is the third step, however, which remains a fertile field for the inventor, and practical processes of decomposition are alone needed, as it is a well known fact that nearly every chemical compound can be decomposed when sufficient electric force is applied to it. The decomposition of chemical compounds by this means demands very careful study and attention, as the results are liable to be influenced to a very large extent by small changes in the physical conditions, such as intensity of current, surface of electrodes and their distances asunder, the nature of the electrodes, and, perhaps most of all, the manner in which the electricity is applied.

We have now in our mind's eye two processes in practical operation, depending for their success upon the economical application of electricity. The Hermite process of electric bleaching is one that has been frequently alluded to in these columns, and depends upon the decomposition of magnesium chloride, while the other is the Webster process for the electric treatment of sewage, which doubtless owes its efficacy to the decomposition of the chlorides that all sewage contains. It is easy to show theoretically how, under one

set of conditions, the process could end in nothing but failure, while under more favorable treatment success may follow, and, as an illustration, we offer a few remarks upon the electrical decomposition of a solution of magnesium chloride.

Everyone knows that the theoretical maximum yields of the laboratory are not to be attained in practice; but combining them with knowlege gained by practice on the large scale, very truthful figures can be obtained.

The reactions which occur during the electrolysis of an aqueous solution of magnesium chloride may be stated for our purpose here as:

$$MgCl_2 + H_2O + H_2O = MgH_2O_2 + H_2 + Cl_2$$

It will be seen that this is not a mere splitting up of the chloride into magnesium metal and chlorine. If it were so, we should have to overcome affinities represented by 93·5 calories.

The chemical equivalent of chloride of magnesium is made up of:

Magnesium	12·0
Chlorine	35 5
Magnesium chloride	47·5
Heat developed in calories	93 5

From which we can easily calculate the number of volts required to overcome the chemical affinity. The formula

$$\frac{He}{23} = E = \frac{93{\cdot}5}{23} = 4{\cdot}06$$

supplies this information, showing that 5 volts would be required in practice, and that 4 volts would not be sufficient.

The gases, however, appear at the electrodes and not the metal, so that we have to overcome the heat of formation of dry magnesium chloride and water, less the heat of formation of magnesium hydrate; this is:

$$75{\cdot}5 \times 34{\cdot}5 - 74\ 9 = 35{\cdot}1 \text{ calories.}$$

If we substitute this value for 9·35 calories above mentioned, we have:

$$\frac{He}{23} = E = \frac{35{\cdot}1}{23} = 1{\cdot}53 \text{ volts.}$$

We do not claim rigid mathematical accuracy for this figure, but the practical proof of its being very near the mark lies in the fact that a strong solution of magnesium chloride can be decomposed by the current from a single Bunsen cell.

The next equation shows us that to produce one kilogramme (2·2 lb.) of chlorine per hour, we shall require theoretically 1·54 horse power:

$$\frac{35{\cdot}1 \times 1{,}000 \times 424}{35{\cdot}5 \times 3{,}600 \times 75} = 1{\cdot}54 \text{ H. P.}$$

and a current of 782 amperes is required, as shown by the following:

$$\frac{1{,}000}{0{\cdot}000355 \times 3{,}600} = 782.$$

This is all fair sailing, but the foregoing figures refer only to the actual work required for theoretically overcoming the chemical affinity of the chlorine for the magnesium; the actual work in practice can only be known beforehand when the resistances are known. In practice the resistances can be easily measured and kept within reasonable limits.

If we allow 50 square centimeters for each ampere of current, a surface of 4 square meters will be required to yield one kilogramme of chlorine per hour; and knowing the specific resistance of a solution of chloride of magnesium, and allowing the distance of one centimeter between each electrode, we can fairly well ascertain what the resistance of the electrolyzing tanks will be, per ampere. The resistance of the conductors can be easily ascertained from their length and section. The counter E.M.F. being $= \frac{\text{Volts}}{\text{Amperes}}$ is also readily calculated. The internal resistance of the dynamo, resistance due to the polarization of the electrodes, and other causes, bring up a total of not less in practice than 0·01 ohm.

$$0{\cdot}01 \times 782 = 7{\cdot}82 \text{ volts.}$$

We have already seen that the actual decomposition requires 1·53 volts, so that the work there realized is but:

$$\frac{100 \times 1{\cdot}53}{7{\cdot}82} = 20 \text{ per cent.}$$

of the total, showing clearly that in practice 7·9 brake horse power is required to furnish one kilogramme of chlorine per hour, which is equal to 2·8 kilogrammes per hour of a bleaching powder of 35 per cent. strength.

In order, then, to replace the equivalent of bleaching powder, equal to the employment of 2·8 kilogrammes (6·2 lb.) per hour, the installation would have to consist of:

A steam engine of 8 brake horse power and a dynamo capable of yielding 6,115 watts of effective current.

This can hardly be called a practical installation; let us multiply it by 8 times, it will then be equal to 50 lb. of bleaching powder per hour, or three tons per working week, and there will have to be installed one steam engine of 64 brake horse power and a dynamo or dynamos yielding, say, 50,000 watts.

We have now to determine on the size and style of dynamos. We may have one passing a large current of low intensity, say 10,000 amperes at 5 volts; or eight separate dynamos each giving 1.250 amperes at 5 volts; or we may have one dynamo producing 1,250 amperes at a pressure of 40 volts.

Although but 1·53 volts are required theoretically to decompose the chloride in solution, yet in practice 5 volts are reached, partly because of the magnesia, which, attaching itself to the cathode, increases the resistance very considerably, and partly on account of the inferior conductivity of dilute solutions, as well as the fact that a considerable current density is necessary, as otherwise the cost of electrodes becomes a most serious question. Five volts may therefore be calculated upon as being absolutely necessary in an ordinary electrolyzer.

But though we have any one of the foregoing alternatives before us, it by no means follows that they are equally efficacious in action. The first proposal, to send a large current of 5 volts intensity through what is practically a pair of electrodes of immense surface is so much at variance with modern experience as to be at once discarded, and the second, to send a weak current from eight smaller machines through eight different tanks, is known to result in such a loss of electric efficiency as to be utterly uneconomical. M. Gramme, in his experiments upon the decomposition of water by a current of low intensity, obtained an efficiency of barely 35 per cent., so that in this ratio it is more than probable that in the case of the first problem an engine of 120 brake horse power would be required to drive the machine necessary to produce the equivalent of 3 tons of bleaching powder per week, and there are besides other grave disadvantages into which it is not necessary to enter here. The second installation may also be dismissed from our minds in a similar line of argument, so that we now come to the third proposition of the dynamo yielding 1,250 amperes at 40 volts, and worked in series through eight electrolyzers. It is in this connection that our calculations lead us to believe that 64 horse power will be consumed in producing the equivalent of 3 tons of bleaching powder per week of 132 hours, or 50 lb. per hour, so that without much trouble we can reckon up the cost of the operation. A brake horse power need not cost more than one halfpenny per hour, bleaching powder, say at £5 10s. per ton at the maker's works, cannot cost the user less than £7 when made into solution in his mill, so that the 50 lb. per hour produced by power, costing 2s. 8d., is value for 3s. 1d., and in this there is no allowance for maintenance of the dynamo or for the loss of electrolyte wasted in the process.

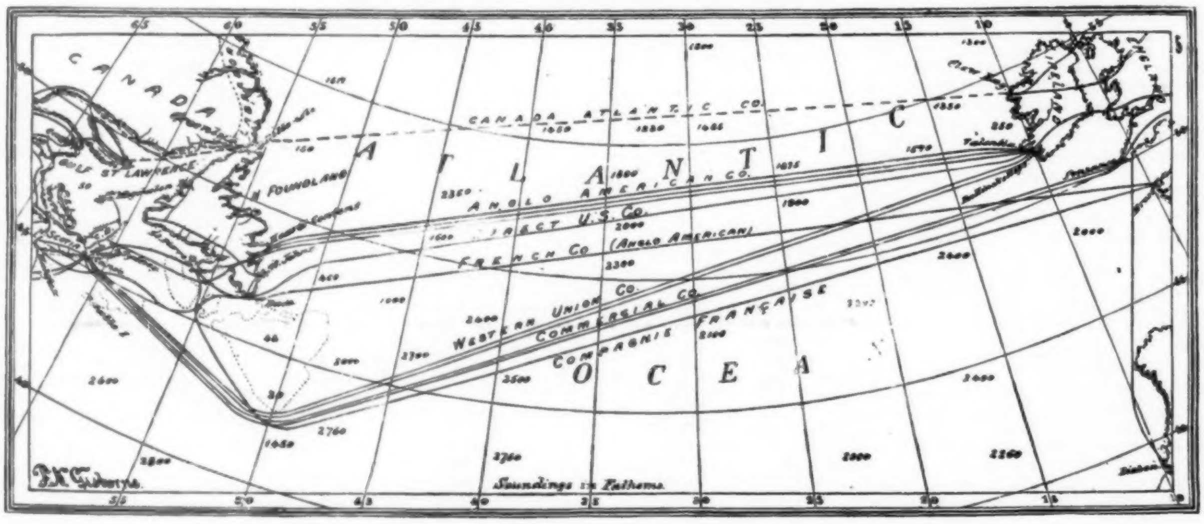
The foregoing picture does not compare favorably for electrolysis as compared with purely chemical methods, but it is not certain that the disposition of the installation, even in the light we have considered it in our third method, is the most satisfactory one that could be devised.

We are of opinion that a dynamo of 500 amperes and 100 volts intensity, working through 20 tanks in series, would prove much more economical. Such a machine will easily yield 90 per cent. of the power applied as available current, in watts, and the cost of 50 lb. of bleaching powder equivalent might be brought down perhaps to 2s., which allows a fair margin for loss of electrolyte and for wear and tear of the dynamo.—*Chemical Trade Journal.*

IN the new system of lighting cars by electricity the train may be broken up at will without affecting the light.

THE TRANSATLANTIC CABLE LINES.

The Dominion Illustrated gives the accompanying plan of the various transatlantic cables, including those in operation and the proposed Canada-Atlantic cable, now before the British Parliament, prepared by Mr. F. N. Gisborne, C.E., F.R.S.C., Chief Superintendent of the Government Telegraph Service in Canada, who has also prepared a similar map showing the Pacific cable systems. The following table gives date and length of several Atlantic cables.



ATLANTIC CABLE ROUTES.

THE ANGLO-AMERICAN CO.'S CABLES.

Laid.	Between.	Nautical Miles.
A.D. 1873.	Ireland and Newfoundland	1,881
" "	Newfoundland via St. Pierre and Cape Breton	293
		2,174
A.D. 1874.	Ireland and Newfoundland	1,840
" 1873.	Newfoundland and Sydney, C. B.	343
		2,183
A.D. 1880.	Ireland and Newfoundland	1,886
" "	Newfoundland via St. Pierre and Cape Breton	360
		2,246
A.D. 1869.	France and St. Pierre	2,648
" "	St. Pierre and Massachusetts, U. S.	759
		3,407

THE DIRECT UNITED STATES CO.'S CABLES.

A.D. 1874.	Ireland and Nova Scotia	2,423
" "	Nova Scotia and New Hampshire, U. S.	560
		2,983

COMPAGNIE FRANCAISE PARIS A NEW YORK.

A.D. 1879.	France and St. Pierre	2,242
" "	St. Pierre and Cape Breton	188
" "	St. Pierre and Massachusetts, U. S.	827
		3,257

THE WESTERN UNION CO.'S CABLES.

A.D. 1881.	England and Nova Scotia	2,531
" 1882.	England and Nova Scotia	2,576

THE COMMERCIAL CO.'S CABLES.

A.D. 1884	Ireland and Nova Scotia	2,350
" "	Nova Scotia and New York, U. S.	841
		3,191
A.D. 1884.	Ireland and Nova Scotia	2,388
" 1885.	Nova Scotia and Massachusetts, U. S.	519
		2,907

THE CANADA ATLANTIC CO.'S CABLE (PROPOSED).

A.D. 1890.	Ireland to Straits of Belle Isle, Can.	1,900

The representative expenditure or share capital of the foregoing companies is approximately as follows:

Anglo-American	$35,000,000	Each line	$8,750,000
Direct United States	6,400,000	" "	6,400,000
Compagnie Francaise	8,000,000	" "	8,400,000
Western Union	14,000,000	" "	7,000,000
Commercial	8,000,000	" "	4,000,000
Canada Atlantic	1,600,000	" "	1,600,000

It is estimated that the *profitably* serviceable continuity of the foregoing cables will be twenty years for the older and twenty-five for the later types; last year's costly experience in repairing the Anglo-American French cable of 1869 is confirmatory of the former calculation.

Thus the three additional cables of the Anglo-American Co. have a prospective existence of four, five, and eleven years, respectively, and it is evident that the hitherto controlling power of the company *re* tariff and pooling dictation is an evil of the past.

The direct United States cable has yet a prospective profitable career of five years; the Compagnie Francaise, ten years; thus the Western Union and

Commercial companies, with their later cables of longer life, have control of the situation, as exemplified by the present established tariff rate of twenty-five cents per word.

The projectors of the Canadian cable claim many advantages over the more southern lines now in existence. Chief among these are the claims that, being 150 miles northward of any transatlantic cable, their line will be in shallower water and absolutely free from risks of repairs to other cables; the company will have no outlay for terminal cables; the capital required will not exceed $1,600,000, and it will cost but one-fifth of the older cables in price, and only one-third as much as the latest preceding cable. It is stated that the present number of transatlantic dispatches relating to Canadian business number 800 per day, and are rapidly increasing; and judging from the dividends paid on the inflated capital of the other lines, the projectors have no fear as to financial results.

MENTHOL IN ACUTE RHINITIS, INFLUENZA, AND OTHER AFFECTIONS OF THE NOSE AND THROAT.

IT may be of value, as claimed by Mr. J. Lennox Browne (*Medical Press*, January 8, 1890), to know that the vapor of menthol checks in a manner hardly less than marvelous acute colds in the head, and is also to be recommended, with a certainty of success if used on its first onset, in arresting or as a preventive of infection in epidemic influenza, and this even for cases in which the nasal symptoms commonly associated with the word influenza are not manifested.

Menthol exerts its action, according to Mr. Browne, in the following manner:

1. It stimulates to contraction the capillary blood vessels of the passages of the nose and throat, always dilated in the early stages of head cold and of influenza.
2. It arrests sneezing and rhinal flow.
3. It relieves, and indeed dissipates, pain and fullness of the head by its analgesic properties, so well known by its action when applied externally to the brow in cases of *tic douloureux*.
4. It is powerfully germicide and antiseptic. It thus kills the microbe of infection, and prevents its dissemination.

The remedy may be employed by means of a general impregnation of its vapor through a room or house, or locally to the nostrils and air passages; for both which purposes there are several methods.

a. A ten to twenty per cent. solution of menthol in almond oil, in liquid vaseline, or in one of the many other odorless paraffin compounds, can be sprayed into the nose or throat, or about a room.

b. By placing 20 or 30 grains in an apparatus designed for administering the drug in cases of laryngeal consumption by inhalation, in the form of vapor mingled with steam.

c. By placing a similar amount, or 1 to 2 drachms of the oily solution, in a steam draught inhaler or bronchitis kettle.

d. By the simple arrangement of placing a saucer of water containing a similar quantity of the crystals over a gas burner in the hall, by means of which the whole house is kept constantly permeated with the drug.

e. But by far the most convenient method for personal use is to carry always the pocket menthol inhaler, which should be used not only on the first approach of an attack, but three or four times a day during an epidemic, and always in cold-catching weather by those subject to head colds.

The instrument consists of a glass cylinder four inches in length, half an inch in diameter, and open at both ends. The tube contains crystals of menthol closely packed and prevented from escape by perforated zinc and cork. The opening at one end is twice the size of the other, the larger being intended for inhalation by the mouth, the smaller for the nostril. The latter is the method which Mr. Browne by preference recommends. It is not to be simply smelt, but well sniffed or inhaled, so as to cause some tingling or smarting, a sensation which is quickly followed by that of coolness, and openness of the previously "stuffed" and heated nostril.

ATHLETIC GYMNASTICS.

MUSCULAR strength is the result of the local effects of exercise. It is the effect of a sort of concentration of the nutritive movement upon the region of the body that works, while vital power, which constitutes health, is the resultant of the general effect of exercise, that is to say, of the influence exerted by work upon the great organic functions in general—respiration, circulation of the blood, and digestion. Now the general effects of exercise are not necessarily in proportion to its local effects. Certain exercises tend to localize the work in the muscles, and certain others tend to make the large internal organs—the heart, lungs, etc.—participate therein indirectly. This distinction is easy to make if we observe the immediate consequences of various exercises that are continued until fatigue supervenes.

Exercise as many times as possible upon the trapeze, and, when you stop through fatigue, the muscles that have taken part in the exercise will be out of service for a few minutes, but your respiration will not be sensibly quickened, and the frequency of the beatings of your heart will not have greatly increased. Now then, change the exercise and run with all the speed that your legs will allow, and you will observe that the fatigue is no longer shown by an aching and powerlessness of the limbs, but by a breathless state of the lungs and a tumultuous beating of the heart.

There are, then, exercises that make their effect felt upon the muscles especially, and others that more particularly influence the large internal organs.

It is for this reason that strength may be given to the muscles through exercise, and that they may even be hypertrophied, without the general state of the individual being sensibly improved for all that, and without the energy of the great vital functions being notably increased.

In many circumstances, an entire group of muscles may be seen to develop with exaggeration, and an entire limb even to acquire great strength under the influence of local work, without the organic functions being influenced by the increase of exercise that has caused the muscular increase. In the lame, for example, we observe an exaggerated enlargement of the perfect leg, because this limb, in order to relieve the other, does double work. So, too, we observe a true hypertrophy of the muscles of the arm and shoulder in certain infirm persons who make up for the powerlessness of the lower limbs by crawling along upon the wrists. And yet in these subjects no important modification of the internal organs and of the functions of nutrition accompanies the increase of the muscles in size. The infirm remain weak in constitution despite the increase in strength (sometimes surprising) that the leg or arm has acquired.

The same result is observed in all cases in which an isolated group of muscles is taxed with an increased amount of work, either through the necessities of a profession or through exercise.

If, by observation, we try to determine in what conditions the effects of exercise confine themselves to a local result, and in what conditions, on the contrary, they interpret themselves by general results, it will be found that all depends upon the quantity of work effected.

The larger the quantity of work represented by the exercise in a given time, the more appreciable will be the effect of the exercise upon the organism in general.

But it must be well understood that "exertion" and "quantity of work" are not synonyms. In order to lift a weight of 100 pounds with one arm, it is necessary to make considerable exertion, because the load is in disproportion to the strength of the acting muscles; but if, in the same task, we employ both arms at once, the exertion will be half less, and yet the "work" remains the same, since the weight lifted has not diminished.

The work is the result of the exertion, and the latter itself is the relation that exists between the work effected and the strength of the muscles that effect it. The wider the divergence between the strength of the acting muscles and the work required of them, the more intense will be the exertion. If a large number of muscles take part together in the exercise, the work may be considerable; but as it will be much divided, each muscle, as it supports but a part, will have to undergo but a moderate stress.

An intense exertion, but one localized in a very limited group of muscles, does not ordinarily represent a quantity of work sufficient to perceptibly disturb the mass of the blood, to quicken the action of the heart and lungs or to notably increase the temperature of the body. On the contrary, several exertions, even very moderate ones, but produced simultaneously in various muscular groups, may suffice to disturb all the organs, and to quicken all the vital functions—respiration, circulation of the blood, calorification, etc.

Upon making energetic and rapid motions with a single arm, we scarcely heat anything but the arm itself; but if we make the same motions with both arms at once, the calorification becomes sensible for the entire body.

If we use our legs at the same time, the heat disengaged is soon great enough to become uncomfortable. So, too, as regards respiration, every one must have remarked to what extent this function tends to remain calm when the exercise is localized, and how greatly, on the contrary, it is quickened when the exercise tends to become general.

If a person fences, in remaining immovable upon the legs and without making a lunge, it is observed that, despite the work occasioned by feints and parades, the respiration presents about its normal tranquillity. The reason is that the muscles of the arms alone work. But if the legs add their work to that of the arms, the lungs at once undergo the influence of the exercise, and, provided that the fencer makes a lunge and quickly straightens, the activity of the respiration becomes such as to put him out of breath.

Every one must have made similar observations *apropos* of the quickening of the pulse.

A small group of muscles entering into play with all the power possible can produce but a slight acceleration of the course of the blood, shown by four or five pulsations more per minute. This increase of activity is so insignificant as to pass unnoticed. But if, the work done by each muscle being the same, a muscular mass ten times greater be brought into play, the result produced may be shown by a figure ten times greater, say an increase of forty to fifty pulsations per minute. Such an acceleration cannot pass unfelt by the subject that supports it, any more than by the organ of circulation, the heart, which is forced to increase its work greatly. The central organ of circulation will therefore be put in play with more energy than in the natural state, and will be exercised at the same time with the muscles; so, too, the lungs and all the organic parts that compose the respiratory apparatus.

This is not all. The superactivity of the heart and lungs indirectly brings about an increase of energy in all the functions of nutrition.

For example, the increase in the action of the heart produces a more active circulation in all the internal organs, at the same time that the acceleration of the motions of the lungs introduces more oxygen into the blood.

It thus happens that a much richer and more frequently renewed blood is sent to the most distant regions of the body, and makes the organs that seem to be the least associated—the stomach, intestines, and bladder, for example—participate in the benefits of the exercise.

These organs contain muscular fibers, which, supplied with a more generous and rapidly renewed blood, acquire more strength. They contain glands and nervous filaments, and all these organs will also be favorably influenced by the contact of the oxygen of the blood, which is both an aliment and an excitant.

That is how the effects of muscular work may make themselves felt in all the molecules of the living body. It is evident that the object of hygiene should be this generalization of the results of exercise, and not the exclusive development of the muscles. And it will be understood that the indications of the exercises of the body should be very different, according as one desires to acquire strength or health.

The "athletic" effects of exercise are not acquired, then, by means of the same processes as its "hygienic" effects. The former are acquired by the local action of muscular work, and the latter by its general action.

It would seem at first sight that there was nothing incompatible between these two classes of results, and one might be tempted to adopt exercises capable of producing both the local and general effects of work—for example, those in which all the muscles work at once, each exerting all the power possible; but, upon a little reflection, we shall very quickly see the practical difficulty of this mode of proceeding: it is the want of proportion between the sum of work that would be effected by the muscles exerting all their energy at once and the sum of work that the organism can support. If we imagine an exercise in which all the muscles of the body come into play at once with all the energy of which each is capable, the effect of the work upon the internal organs and functions would be of excessive intensity, and the general effects of the exercise would make themselves felt with a violence such that the heart, lungs, and blood vessels would be exposed to a dangerous test.

So two different tendencies are seen to be very sharply defined in the various methods of exercise. One concentrates the work in a definite region of the body, the other divides it among a large number of muscles. The former proceeds, as it were, by analysis. Aiming to give the muscles all the strength and development possible, it demands of them a considerable exertion and confines the latter to an isolated region in order to avoid an excess of action upon the great vital functions.

In this manner the subject can carry the muscular exertions up to the limit of exhaustion of the muscles without being stopped by those complex functional troubles which constitute fatigue, and prominent among which is breathlessness. Fatigue remains then localized in the muscles that act, and it is thus possible, after fatiguing one muscular group, to pass to another. In this way it is possible to work, *in succession*, and with greater energy, all of the muscles of the body without very sensibly quickening the circulation of the blood, respiration, and calorification. It is thus, for example, that gymnastics with apparatus proceeds. So to speak, it divides the body up into a series of muscular regions, each of which in turn receives its contingent of exercise.

Certain apparatus especially exercise the flexor muscles; certain others more particularly exercise the extensors.

What are called board exercises still more strikingly present that character that might be called analytical, and which consists in working the entire body in detail without the work ever generalizing itself in all the muscles at once. They set all the muscles in action, but successively and group by group. These exercises are excellent for developing all the muscles of the body, provided every motion is made with all the vigor and energy possible. We can add to the expenditure of strength by executing these isolated motions with halters grasped by the hand and moved in various directions, or by weights that are lifted and held out straight.

In this way it is possible to strengthen and increase such or such a muscle at will and localize the athletic aptitudes in the region in which it is desired to utilize them.

It is by maneuvering those apparatus called dumb bells that the English boxers acquire a great strength of arm and shoulder.

So, when we desire the athletic effects of exercise, preference must be given to exercises that localize the stress and concentrate the work; but if we want to obtain hygienic effects, it must be all otherwise. It is necessary to proceed then by *synthesis*, if we may so express ourselves. Far from seeking local stresses, it is necessary to give preference to exercises that generalize the work and make the largest number of muscles possible participate in it.

In this way, its influence will be felt in all the great functions of the economy, and the large internal organs will be associated in the exercises, without there being any need of imposing very much fatigue upon the muscles. Each muscular bundle will undergo but moderate stress, but the sum of work represented by the exertion of each may, as a whole, be large. The exercise may thus, without leading to local fatigue, notably accelerate the respiratory motions and pulsations of the heart, very sensibly increase the temperature of the body, and, in a word, produce the "general effects" of the work.

Gymnastics with apparatus is the type of the methods of which the object is to develop muscular strength. For this reason, it will be an eminently athletic method; but it is not the ideal of exercise from a hygienic point of view, because it produces local, not general, effects.

In exercising the arms, in the different motions that the apparatus necessitate, scarcely anything but local effects are produced; and the proof is that, if we carry the exercise to fatigue, the fatigue felt will be local. We shall be stopped in the exercise by an aching and exhaustion of the acting muscles, and not by that general perturbation of all the great functions which results from the exaggerated activity of the heart and lungs, and which is characterized by breathlessness.

So the need has been felt of adding to exercises with apparatus other exercises that tend much more to generalize the work, and some years ago running and leaping were introduced into all gymnasiums. These two exercises bring into play numbers of the muscles of the lower limbs, and associate in the work of these all the muscles of the pelvis and trunk.

They also act much more upon the great vital functions than upon the muscles. Every one knows that a run of five minutes quickens the respiration and circulation more and heats the body more than do three-quarters of an hour of gymnastics with apparatus. These exercises, annexed, in a manner, to rope exercise, and which seem to be considered an accessory, are in reality the true hygienic part of the lesson of gymnastics, and the one that should be preserved rather than the other, in case one of the two has to be sacrificed.

We should like to see a clearer distinction established between these two so different indications of the exercises of the body, according as strength or health is demanded. In the first case, it is necessary to perform *athletic* exercise, and in the second *hygienic*, and nothing is rarer in practice then to see applied, with discernment, the gymnastic method that responds rationally to the one or the other of these two so different indications. In most cases, the processes of athletic gymnastics are applied to delicate subjects whose vital functions are languishing, and in whom it would be

necessary simply to quicken the play of the organs. An endeavor is made to give them larger muscles, while what they really need is larger lungs, a stronger heart, a more contractile stomach, and blood richer in oxygen. In a word, it is forgotten that health is a resultant of which muscular strength is but one element, and not the most essential one. Besides, muscular strength can be increased by exercises that in nowise proceed from athletic methods and which do not act by their local effect.

What observer has not been struck to see the strength of the child's arm increase as a result of certain exercises that set the legs alone in motion? We have performed a very simple experiment upon ourselves that proves without doubt that an exercise is capable of leading indirectly to an increase of the strength of the muscles not brought into play. Having had occasion to pass six weeks in the mountains and to employ the time in walks progressively lengthened, we have noted the strength of the hand, by means of a dynamometer, on arriving and starting, and have ascertained an increase of twenty-six pounds in the energy of the pressure, consequent upon something in which the muscles that close the fingers could have taken no direct part. It is in the same way, by indirect effect, that we see the muscular tunics of the stomach, intestines, and bladder acquire strength under the influence of bodily exercise; and it will be understood that these muscular fibers, which are not under the control of our will, cannot have undergone the influence of exercise otherwise than by the greater activity given to all the organic functions, especially to the respiration, which introduces into the blood that powerful stimulant of muscular force, oxygen.—*F. Lagrange, in Revue Scientifique.*

THE OPTICAL ILLUSIONS AND LIGHTS AT BARNUM'S.

In such a much-advertised venture as this "greatest show on earth" there must be among curiosities displayed things that one has not seen before, as well as old friends; so with a view of taking notice of the show from an optical point of view, and seeing what was peculiar or new, I visited it the other evening, and was duly entertained as thousands had been before me. The natural curiosities are outside my domain, beyond a passing remark that all the people, great and small, would have looked much better if they had had a background of bunting instead of the plain brick wall, and were better lighted. It is all the more remarkable that they should be thus scantily cared for when the expenditure has been so lavish in the matter of "Nero" and the pageants.

The optical illusions are decidedly good, and include such things as "The Mermaid," "The Swinging Bust," and others, showing the face, shoulders, and arms of a woman, with the lower part of the body and legs hid cunningly in such a way behind a screen or curtain, while an artificial bust is ·ed to keep up the illusion. In the case of the "mermaid" the tail is attached to the bust. The bodiless woman (Queen Anne) shows a head only, with a large collar round the neck. This, there is little doubt, is produced by passing the head through a large hole in a looking glass placed at an angle of forty-five degrees to the top and back of the box or niche (containing the illusion), which is papered with a distinctive pattern, so that by reflection the top looks, when viewed from the front, to be the back of the box.

A capital illusion is the "Galatea" statue, which apparently comes to life, opens the eyes, the color comes to the face and hair, and then changes to a skeleton. Here by reflection and a dissolving view principle, the living woman's bust is made to superimpose the statue, and afterward the skeleton to cover the woman's face and shoulders. The hand shaking by the attendant who introduces the illusion is remarkable, and should be seen by all your readers, and their own construction put upon it; for it would be unfair to the management to let out all the secrets.

With the lady who apparently disregards the laws of gravity one has a most interesting experience, for she not only supports herself in mid-air at will, but revolves with arms and legs extended in graceful attitude without any visible support. This is again done by reflection, a glass being placed at such an angle as to cause an illuminated object placed horizontal (lying down) to appear vertical. The body of the woman is placed in a revolving wheel in such a way that she is supported by the waist, and there is depth enough for the arms and legs to move freely; besides this, there are rollers attached for readily sliding the body backward and forward, so as to come in and out of the field of view. In this way the figure is made to rise up or dive down when required, and thus create a great impression on the audience.

Incandescent electric lights are used to illuminate the outside of the boxes or niches in which the illusions are shown, and as the powerful reflectors are placed so that the light falls on the eyes of the spectators, they are at a disadvantage, and have more difficulty in detecting "how it is done," the figures being illuminated by strong lights hidden behind curtains or screens.

The lime light used in the large hall to illuminate the performers is different to what is used in England, parabolic reflectors being employed instead of bull's-eye condensers for concentrating the light. These, while very good for general illumination over a large area, would probably not be so good as the English plan for single objects or concentrated illumination. Condensed gas is employed, but the cylinders are much larger than the steel ones used in England, and the pressure contained in same is far less than that now in general use here. The side of the lime cylinder next to the reflector is made incandescent, and not the side next to the object, as when using condensing lenses. The gas is regulated from the cylinders, and not from the taps or through an automatic regulator, as would be the case if higher pressure gas cylinders were employed; but as Barnum's people make and compress their own gas, portability is (within reasonable limits) not studied. There are twenty-five of these lime lights in use for the lighting up of the stage and arena—thirteen for the former and twelve for the latter; and to give some idea of the vastness of the place and the brilliancy produced, there are besides these lime lights over one hundred electric arc lamps, fifty-eight of them being in the arena (six in a cluster), eight on the stage, sixteen in the stables and menagerie, and the rest under the gallery and outside the entrances. For the majority of buildings where a lime light is required, I don't think, however, it will be found that the reflecting light is more suitable than the condenser plan.—*G. R. Baker in Br. Jour. of Photo.*

AN EXPERIMENT IN OPTICS.

Any one can repeat the experiments that we are about to describe, for they necessitate the use of nothing but a pin and a translucent visiting card. The pin will serve in the first place for making a small and well defined aperture in the card.

First Experiment.—Upon holding the card against the eye, it will be readily seen that the power of accommodation is much increased. A long-sighted person will see the head of the pin distinctly at a distance of three quarters of an inch from the eye, while a very short-sighted person will, without trouble, distinguish pointed characters at a distance of 15 or 20 inches. This experiment has been known for a long time, and we mention it merely to recall its relation to photography without an objective.

Our eye, as a photographic objective, is wanting in depth, in other words, it is perfectly accommodated for a definite distance only. For example, let us look at the wall of a room, and let us pass a card, in the

Fig. 1.—METHOD OF OBTAINING THE REVERSED IMAGE OF A PIN.

visual field, at a few fractions of an inch from the eye. The card will appear very indistinct to us, and, if we direct our attention to it, the wall will seem to disappear. Placing the small aperture before one eye, let us repeat the experiment, and we shall see both the card and the wall at the same time and with perfect distinctness. All objects will appear absolutely flat. The retinal images will have the same distinctness as in the camera provided with a small aperture or with a well diaphragmed objective.

Second Experiment.—Now let us place the card at a distance of an inch and a quarter from our eye (Fig. 1), and through the small aperture let us look at a well illuminated surface (the globe of a lamp, for example), and let us place the pin about midway between the eye and the card. If the pin moves from right to left, we shall see it move from left to right. Upon carefully removing it, we shall see the head delineated in the aperture on the side opposite to that at which it is situated. In other words, we shall see the reversed image of the pin. This experiment is well known, and we shall endeavor to explain it.

As well known, the images of external objects are reversed upon the retina (Fig. 2, No. 1), and we righten them through education. A direct image must therefore appear to us reversed. Now, in the present experiment, the small aperture acts solely as a luminous point, A (Fig. 2, No. 2), and projects the shadow of

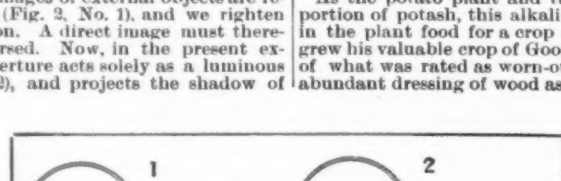


Fig. 2.—EXPLANATION OF THE PHENOMENON.

the pin upon the back of the eye. The pupil here plays the part of a wide aperture—it is a simple window.

The experiment may be varied in different ways. If we half close the eye before the aperture in the card, we distinctly perceive its lashes, which appear reversed. Finally, on moving the card slightly backward and forward, or, better yet, on making the aperture describe a small circle, the visual field will soon appear covered with a network of branches. Such vision is due to the shadow of the blood vessels upon the sensitive layer of the retina. This last experiment is not always a success at first, and when, after one or two minutes, the phenomenon does not occur, it is better to give it up rather than tire the eye too much.—*La Nature.*

THE POTATO.

The first great advance in perfecting the quality of the potato was made in the production of the Mercer variety, which was named after the county in New York where it originated. Being large, white fleshed and mealy, it soon took the preference over the Blueskin, Foxite, and other varieties of the period, and spread throughout the country from Maine to the far West. In time the Mercer deteriorated, became subject to disease, and the plants decayed prematurely.

The potato rot of 1844 and in later years worked a revolution in potato culture, mainly through the wisdom of the Rev. Chauncey E. Goodrich, chaplain of the insane hospital at Utica, who conceived the idea that to make the tubers hardy they should be reproduced from wild Peruvian and Chilian stock. With this view he imported wild tubers in the years 1849, 1850, and 1851, and by cultivation produced in 1853 the Garnet Chili, which became the parent of a long line of hardy, improved, palatable, white fleshed tubers obtained by hybridization. Mr. Goodrich is credited in Europe with having established a new era in potato growing, from the thousands of seedlings which he tried and distributed for trial. His work was one of pure philanthropy. Other men made large sums of money out of his valuable novelties, while he contented himself with the good he was doing to humanity. He died poor, when perhaps he ought to have been more provident, as his daughters were obliged to live by teaching.

Wild Chilian potatoes have also quite recently been tested and found unusually hardy by my correspondent, the celebrated botanist and seedsman, M. Henrie Vilmorin, of Paris, who is celebrated for his zeal in introducing and domesticating wild esculents. Although Baron Von Humboldt stated that there were no potatoes under cultivation in Mexico at the time of the conquest, wild tubers from her mountain lands have been grown in France and in this vicinity. The effect of cultivating wild tubers in a rich soil is shown by a persevering experiment made by Mr. Alfred Rose, of Yates County, New York. About the year 1879 he planted one wild potato of the size of a pea, and obtained as a product one tuber of the same size. Such a result would have ended the trial with many; but he planted this little product and obtained a tuber of the size of a large pear, which, being planted, did still better, until in the sixth season there was a product of nine tubers, the planting of which, in the seventh summer, yielded nearly two bushels of smooth, handsome, potatoes, weighing from four ounces to a pound each.

The experiments of Goodrich deserve repeating on a much larger scale, and with wild tubers of California, Arizona, Texas, Mexico, Central America, Peru, and Chili. Selections of these should be used in hybridization, and their seed products planted and tested until new, valuable, and hardy potatoes are obtained for the table. There was a fortune in the production of Bresee's Early Rose, and this result may be repeated. Our late secretary, Mr. A. W. Harrison, gave this potato its name from its character and color, and on one occasion he made an exhibition of some of Mr. Goodrich's seedlings in bushels at the autumnal fair of our society, raised by him in Germantown.

Fabulous sums were paid for the Early Rose the year of its production. I have known of $20 having been paid for a peck, $3 for a pound and $2 for a five ounce tuber, this last by the late Peter Henderson, who produced from it a crop of 450 pounds from 150 plants raised by forcing, sprouting, and rooting. By this system, in a hot bed, 2,000 plants, and almost 2,000 pounds of potatoes, have been produced from one pound, or by measure thirty-three bushels, of Ruby potatoes, worth at the time $74.

The value of a new potato does not depend altogether upon its size, form, productiveness, hardiness, and taste; for we must also consider the proportion of starch which it yields by analysis, a test of quality which is too seldom employed. On the average a potato will yield in October from eighteen to twenty per cent. of starch and seventy-five per cent. of water, but the former ranges from ten to twenty-three per cent., and the latter from sixty-eight to eighty-two per cent. The starch exists in the largest proportion in October, and diminishes gradually until April, when the loss is sometimes as much as three per cent.

Potatoes should be boiled in their skins if economy is to be considered, as the loss to the water is then only three per cent., as against fourteen where they have been pared; or from two to three ounces in the pound, which is a very considerable waste.

As the potato plant and tuber contain a large proportion of potash, this alkali is an important element in the plant food for a crop of tubers. Mr. Harrison grew his valuable crop of Goodrich seedlings on a piece of what was rated as worn-out land, by the aid of an abundant dressing of wood ashes.

The potatoes of to-day are quite different in appearance from those grown fifty years ago, when their eyes were much sunken and their surfaces covered with nodules. American tubers are much more symmetrically formed than those of foreign countries in general and of more uniform size. Very large tubers evince a richness of soil, but are no special advantage to the consumer. Russia produces very large potatoes, but they have deeply set eyes, and are not invitingly shaped. The tubers of Europe are generally light yellow in flesh; some are very dark skinned, and the more common shape is short and thick. Selection of shapes for planting should improve the form of the potato, as it has done with the tomato. "Plant the best, and eat or sell the balance," is a rule that holds good for crops in general, but it is a difficult one to secure acquies-

cence in among the ignorant and improvident. Following just the opposite in Ireland has had much to do with her potato failures and famines. It is a self-denial not to eat the best of the crop, when the lowest grades will sprout and grow, but this self-denial pays in the end, whether it be in the potato, Indian corn or wheat.—*From a paper read before the Pennsylvania Horticultural Society by Robert P. Harris, M.D.*

THE REVOLUTION OF MERCURY.

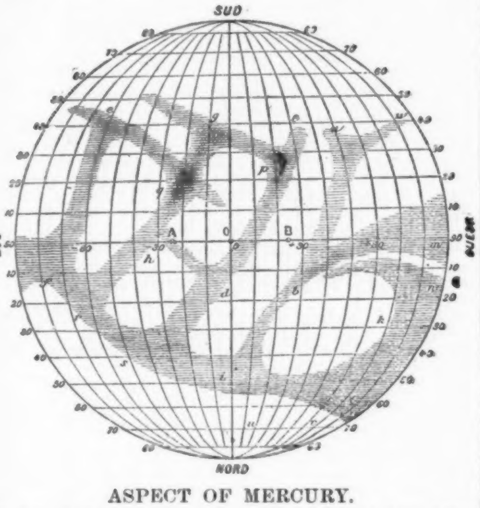
NEARLY a century has passed since Schroter, the indefatigable astronomer of Lilienthal, determined the time of the planet Mercury's revolution. Meanwhile, up to recent times, no one has expressed a doubt as to the accuracy of the value that this illustrious man assigned to the length of the day of this world so near the sun.

The "Annuaire" of the Bureau of Longitudes for 1890 still publishes the figure of 24 h. 0 m. 50 s. It would, therefore, come near to our day, since it would differ only by the three-hundredth part of its value.

Mr. Schiaparelli has for several years been making observations (which are very difficult) upon this star, which, in its greatest elongations, does not recede more than 27° from the sun.

Very fortunately, aided by a much more favorable sky than that of the environs of Bale, the director of the Milan Observatory has succeeded in making a hundred and fifty satisfactory observations. It is well to note that these were not made with a telescope of a power greater than that used by Schroter. It is not that the director of Milan had much more powerful instruments at his disposal. Mercury can be observed only when it is near the horizon and at twilight or daybreak; it is this very circumstance, known to the ancients, that has caused it to be consecrated to the god of robbers. It is therefore impossible to use a strong magnifying power without sacrificing distinctness.

At the beginning of the last century, an astronomer of Toulouse, named Vidal, had acquired a certain celebrity that he hardly owed to anything except his ability to follow Mercury near the sun. On the 11th of August, 1887, Mr. Schiaparelli certainly surpassed Vidal, since he followed the planet at 3° from the limb; but, if our memory serves us, he did not surpass Schroter, who, as well as Vidal, merits the names of Trismegistus



ASPECT OF MERCURY.

Facsimile of a drawing by Mr. Schiaparelli. Visible hemisphere of Mercury (reversed as seen in the telescope). First system of dark parallel spots: 1° *f r s i*; 2° *e q*; 3° *g p*. Second system: 1° *e f*; 2° *g q r*; 3° *e d p s*; 4° *a b i*. White spots: 1° *u v*; 2° *b k*; 3° *a d*. Black points, probably eminences, *p* and *q*.

and Hermophilus.* What is certainly very curious in the discussion that begins is that Mr. Schiaparelli may be right without doing prejudice to the glory of Schroter. In fact, the consequences at which it stops might be drawn from Schroter's observations. The Milanese director agrees with him of Lilienthal in recognizing the chief fact. Both admit that, on the surface of Mercury, there exist spots due to eminences that do not change from one day to another. These are recognized as well as could be possible on the surface of a disk whose diameter does not exceed eight seconds.

The form of these spots is evidently very difficult to define. Every observer infuses a little imagination in the results that he announces. It is not necessary to note the differences that exist between the drawings given by scientists operating under circumstances so different. We therefore content ourselves in placing before the reader's eyes a fac-simile of the drawing in which Mr. Schiaparelli sums up the long work to which he has devoted himself under so difficult circumstances.

He believes that he has perceived a system of black radii remaining constantly parallel, then a second system a little less distinct offering a different orientation. According to him, the eye, on examining these lines of shadows for a long time, at length discerns therein almost as clear details as those observed in observations of Mars. He claims too that he has recognized the place of brilliant regions, that is to say, more resplendent than others. The changes that he has observed during long periods do not appear to him to be due to those that would result from a true revolution of Mercury around its axis. He finds them analogous to those that we recognize upon the moon's disk, and he thinks that, like those, they are connected principally with the differences of the situations of the earth joined with a species of libration of which we shall speak hereafter. He has drawn the conclusion therefrom that Mercury always presents the same hemisphere to the sun, because to every angle described by the planet in its movement of a revolution there corresponds a precisely equal angle traversed in its rotation around the axis of its diurnal revolution.

Mercury would then be exactly opposite the sun in the same position as the moon opposite the earth; and the time of its revolution around its axis would be identical with that of its sidereal revolution, which, according to the admitted figures, is eighty-eight mean terrestrial days, less one hour.

Between the two celestial bodies there is another analogy connected with the laws of elliptical motion to which both are subjected. Although equal to this sidereal motion, the revolution around their axis is uniform, while their motion of circulation around the central point of their orbit is more rapid when they are near the focus than when they are more distant from it.

As the eccentricity of Mercury is four times greater than that of the moon, the advances or retardations are much greater.

The zone that now sees the sun and is now deprived of the sight of it has transverse dimensions relatively much greater than upon the moon. But between the two hemispheres of Mercury there is another and very important difference. One of the hemispheres constantly sees the sun, and a portion of the other is constantly involved in an eternal night. Half of this globe is exposed to a heat ten times greater than that of our torrid regions, and that too without rest or respite, without twilight, without night, and without daybreak! The other half, on the contrary, remains constantly at the temperature of planetary space, of which our polar regions furnish but a feeble image.

It was the difficulty of accepting such conditions that led Schroter to reject this hypothesis. If, with Schroter, who had the support of Bessell, we suppose that the revolution of Mercury around its axis differs very little from the revolution of the earth, the permanency of the spots at the same points of the disk is no longer surprising.

Before awarding a verdict in favor of the Italian astronomer, who has seen the canals of Mars, and so many other things, it will certainly be necessary to await a confirmation of his ideas and observations. While congratulating him for his zeal, will it not be well to remain in prudent reserve?—*La Nature.*

* These are the names given to Vidal by Lalande.

TRANSIT OBSERVATIONS BY PHOTOGRAPHY.

By WILLARD P. GERRISH.

A PAPER read by Mr. W. E. Wilson before the Royal Astronomical Society at its meeting December 13, 1889, calls attention to a device for taking transit observations by photography. It may be of interest to note that experiments were made at Harvard College Observatory as early as January, 1886, on the plan proposed by Mr. Wilson. Photographs were made of the Pleiades with the eight inch Bache telescope, with a view of determining the degree of accuracy with which time could be determined. The star images were allowed to trail over the plate, the telescope remaining at rest. Exposures of different lengths were given, and the images were afterward measured. The discussion showed that a single setting on an image made by an exposure of one second could be made with a probable error of only 0s·03. An account of this work can be found in Memoirs of American Academy, vol. xi., p. 218.

The subject was again taken up in the summer of 1888, and experiments were continued by Professor F. H. Bigelow and the writer. A photographic plate was attached to a common telegraph sounder and placed at the focus of a six-inch telescope. The plate was moved with an alternating motion at intervals of one second in a plane perpendicular to the axis of the telescope. The direction of this motion was parallel to the meridian. The star image was allowed to trail across the plate by the diurnal motion. Two rows of dots were thus formed, each dot representing one second of time.

After these preliminary experiments, Professor Bigelow constructed an experimental apparatus more especially adapted to the work. This was used with the same telescope and gave very good results. It was fitted with a small plate holder which was connected with the armature of a magnet by which the motion was imparted. A reticule of raw silk fibers was placed at the focus of the telescope, and an impression of this reticule was made on each plate by throwing the light of a lantern into the objective for an instant, slightly fogging the plate. The wires appeared as distinct light lines on a slightly darkened background, though not sufficiently dark to obscure the star images. An attempt was made to operate the instrument directly from the sidereal clock of the observatory. The clock has an ordinary break circuit attachment, and the signal was found to be of so short duration that it made no appreciable break in the star trail.

In the autumn of the same year a complete set of apparatus of fine workmanship was constructed from the plans of the writer. It consists of two separate and independent instruments, one being designed to transform the signals of an ordinary clock into alternating signals, and the other being a small tail piece carrying the magnet and mechanism to be attached to the transit instrument.

The alternating machine is not unlike an ordinary telegraph relay in appearance. A large magnet in the circuit of the standard clock actuates an armature lever which has at its upper end a pawl engaging the teeth of a ratchet wheel. The wheel moves one tooth at a time with each movement of the armature and turns a contact wheel. Upon this rests a spring completing a local circuit operating the mechanism on the telescope. Alternate sections of the contact wheel are cut away, so that the local circuit is alternately opened and closed with each signal on the clock circuit. A second contact wheel on the same arbor with the first is cut away, to give signals of two seconds duration, for use on northern stars where the one second interval would make the images too near together. A switch serves to send the local current through either of these at the will of the observer.

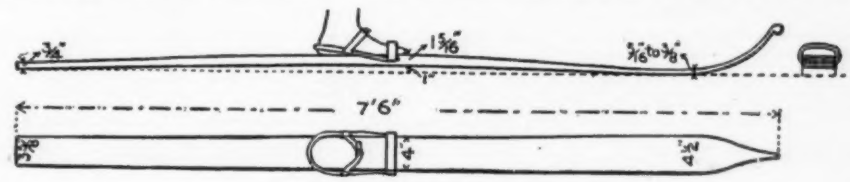
The tail piece consists of a brass box 4 inches long, 2¼ inches wide, and 1⅜ inches deep, weighing with its contents and attachments 17¼ ounces. It has on its side an opening which fits the adapter of the telescope. In this box is a small electro-magnet, to the armature of which is attached a small square photographic plate, measuring 1¼ inches on a side. The plate is held in position by a spring clamp which prevents any accidental slipping. The plate has a motion of about 0·01 inch, the amount being regulated by two adjustable stops, between which the armature vibrates. The frame, or clamp, carrying the plate is hung on a system of parallel levers similar to a parallel ruler, and so arranged that it can move only in a direction parallel to the meridian. All of the bearings are hardened steel points, fitted with springs to take up all lost motion and to prevent the plate from changing its position after having been once adjusted.

An important feature of this portion of the apparatus is that the plate is clamped directly to the armature lever of the magnet, without the interposition of a plate holder. This greatly reduces the chance of error from the slipping of the plate. As the recticule is rigidly and permanently attached to the telescope, it is only necessary that the plate should remain accurately in place during the observation until the impression of the reticule is finally made upon it. The brass box serves as a plate holder, being so small and light that it can readily be detached and carried to the dark room to be recharged with a fresh plate. A small slide which covers the opening in the box serves to exclude the light when it is detached from the telescope.

A small three inch transit instrument was chosen for the work, and the apparatus was fitted to it. Observations were made on several of the brighter stars, but owing to the small aperture of the telescope, stars fainter than the third magnitude could not be taken. An instrument for use with the device should have a very large angular aperture.—*Sidereal Messenger.*

THE NORWEGIAN "SKI."

THE ski (pronounced "ske"), says Mr. K. Zimmer, is noticed in Norwegian history as long as 800 years ago, and the ancient shape has been essentially preserved to the present day, as shown in the illustration here given, which is a scale drawing of the snow shoe as now used in Norway. It is made of pine, ash, or oak, and is used up to this day in conveying the mail from Kristiania to Bergen, when the coast mail steamers are detained by winter storms, as also in the mountain valleys, where in winter the snow is too deep for other conveyance. As a means of traveling it is commonly used by all the peasants, men, women, and children.



THE TRUE NORWEGIAN "SKI."

Besides serving the useful purposes just referred to, it has developed into the most popular sport in Norway, and the Feb. 1 race on the ski is of akin in the interest excited to the English Derby. This race is generally attended by the royal family, the whole court, and many tourists from foreign parts.

The steepest hill near Kristiania is selected, and in the middle of the hill a "jump" is built up about 7 ft. high. The participants in the race come sliding down on their ski with a speed exceeding that of a railway train, and passing the "jump," they fly through the air for 75 ft. or more. The expert skaters land on their feet and continue the descent as if no interruption had occurred—the others don't.

The usefulness of the ski as an important factor in future Arctic explorations has been proved by the experience of Dr. Fritzjof Nausen, who with five men made a trip on the ski through the interior of Greenland in the summer of 1888.

The *Mining and Scientific Press*, of San Francisco, in a late issue describes the snow shoe illustrated in our issue of Jan. 18, and adds some further matter of interest regarding its use in races in the Sierras. The *Press* says that these racing shoes are from 10½ to 13½ ft. long and from 3¾ to 4¼ in. wide, with a ⅜ in. groove 1½ in. wide on the bottom. The bottom of the ski is highly polished, and tar is burned and rubbed in until a full, mahogany-like finish is obtained, which hardens the wood, makes a smooth surface, and attracts heat when exposed to the sun.

On the top of the shoe, a little back from the center, there is about 18 in. of wood left flat, and toward the front they are shaved and planed so as to leave the point springy. There is considerable wood left behind the center as a counterbalance, so that in running over rough places there will be no sudden jerk to endanger the equilibrium of the user. This is essential, as a speed of 60 to 80 miles per hour can be attained on these shoes, and they have a decided tendency to "buck" when going over uneven snow.

The bottom of the ski is lubricated, and the "dope" used for this purpose varies with the views of the racer and the condition of the snow—a soft dope for soft snow and hard dope for frozen snow. This "dope" is made from all manner of ingredients; gum, beeswax, resin, sperm candle, etc., will do for ordinary traveling; but for racing the ingredients vary much, and their compounding becomes more intricate; its manufacture is a "trade secret" with the racer, as a rule.

The *Press* says that in racing, confidence is the first requisite; timidity is fatal. The racer rides very low on the shoes, in a "squatting" position, with the brake pole in the right hand. The racing track is usually from 1,000 to 2,000 ft. long, with slopes of 15° to 35°, but must lie in a straight line. It is said that it is no unusual thing in these races to see the shoes continue the course alone, and the rider meanwhile make strange gyratory motions in the air in seemingly vain efforts to restore things to a normal condition.—*Eng. News.*

U. S. STANDARD WEIGHTS AND MEASURES.

The following tables have been issued from the Office of Standard Weights and Measures, United States Coast and Geodetic Survey, T. C. Mendenhall, Superintendent:

TABLES FOR CONVERTING U. S. WEIGHTS AND MEASURES—CUSTOMARY TO METRIC.

LINEAR.

	Inches to millimetres.	Feet to metres.	Yards to metres.	Miles to kilometres.
1 =	25.4000	0.304801	0.914402	1.60935
2 =	50.8001	0.609601	1.828804	3.21869
3 =	76.2001	0.914402	2.743205	4.82802
4 =	101.6002	1.219202	3.657607	6.43739
5 =	127.0003	1.524003	4.572009	8.04674
6 =	152.4003	1.828804	5.486411	9.65608
7 =	177.8003	2.133604	6.400813	11.26543
8 =	203.2004	2.438405	7.315215	12.87478
9 =	228.6004	2.743205	8.229616	14.48412

CAPACITY.

	Fluid drams to millilitres or cubic centimetres.	Fluid ounces to millilitres.	Quarts to litres.	Gallons to litres.
1 =	3.70	29.57	0.94636	3.78544
2 =	7.39	59.15	1.89272	7.57088
3 =	11.09	88.72	2.83908	11.35632
4 =	14.79	118.30	3.78544	15.14176
5 =	18.48	147.87	4.73180	18.92720
6 =	22.18	177.44	5.67816	22.71264
7 =	25.88	207.02	6.62452	26.49808
8 =	29.57	236.59	7.57088	30.28352
9 =	33.28	266.16	8.51724	34.06896

SQUARE.

	Square inches to square centimetres.	Square feet to square decimetres.	Square yards to square metres.	Acres to hectares.
1 =	6.452	9.290	0.836	0.4047
2 =	12.903	18.581	1.672	0.8094
3 =	19.355	27.871	2.508	1.2141
4 =	25.807	37.161	3.344	1.6187
5 =	32.258	46.452	4.181	2.0234
6 =	38.710	55.742	5.017	2.4281
7 =	45.161	65.032	5.853	2.8328
8 =	51.613	74.323	6.689	3.2375
9 =	58.065	83.613	7.525	3.6422

WEIGHT.

	Grains to milli-grammes.	Avoirdupois ounces to grammes.	Avoirdupois pounds to kilogrammes.	Troy ounces to grammes.
1 =	64.7989	28.3495	0.45359	31.10348
2 =	129.5978	56.6991	0.90719	62.20696
3 =	194.3968	85.0486	1.36078	93.31044
4 =	259.1957	113.3981	1.81437	124.41392
5 =	323.9946	141.7476	2.26796	155.51740
6 =	388.7935	170.0972	2.72156	186.62089
7 =	453.5924	198.4467	3.17515	217.72437
8 =	518.3914	226.7962	3.62874	248.82785
9 =	583.1903	255.1457	4.08233	279.93133

CUBIC.

	Cubic inches to cubic centimetres.	Cubic feet to cubic metres.	Cubic yards to cubic metres.	Bushels to hectolitres.
1 =	16.387	0.02832	0.765	0.35242
2 =	32.774	0.05663	1.529	0.70485
3 =	49.161	0.08495	2.294	1.05727
4 =	65.549	0.11327	3.058	1.40969
5 =	81.936	0.14158	3.823	1.76211
6 =	98.323	0.16990	4.587	2.11454
7 =	114.710	0.19822	5.352	2.46696
8 =	131.097	0.22654	6.116	2.81938
9 =	147.484	0.25485	6.881	3.17181

1 chain	=	20.1169	metres.
1 square mile	=	259	hectares.
1 fathom	=	1.829	metres.
1 nautical mile	=	1853.27	metres.
1 foot = 0.304801 metre,		9.4840158	log.
1 avoir. pound	=	453.5924277	gram.
15432.35639 grains	=	1	kilogramme.

The only authorized material standard of customary length is the Troughton scale belonging to this office, whose length at 59·62° Fahr. conforms to the British standard. The yard in use in the United States is therefore equal to the British yard.

The only authorized material standard of customary weight is the troy pound of the mint. It is of brass of unknown density, and therefore not suitable for a standard of mass. It was derived from the British standard troy pound of 1758 by direct comparison. The British avoirdupois pound was also derived from the latter, and contains 7,000 grains troy.

The grain troy is therefore the same as the grain avoirdupois, and the pound avoirdupois in use in the United States is equal to the British pound avoirdupois.

The British gallon = 4·54346 liters.
The British bushel = 36·3477 liters.

TABLES FOR CONVERTING U. S. WEIGHTS AND MEASURES—METRIC TO CUSTOMARY.

LINEAR.

	Metres to inches.	Metres to feet.	Metres to yards.	Kilometres to miles.
1 =	39.3700	3.28083	1.093611	0.62137
2 =	78.7400	6.56167	2.187222	1.24274
3 =	118.1100	9.84250	3.280833	1.86411
4 =	157.4800	13.12333	4.374444	2.48548
5 =	196.8500	16.40417	5.468056	3.10685
6 =	236.2200	19.68500	6.561667	3.72822
7 =	275.5900	22.96583	7.655278	4.34959
8 =	314.9600	26.24667	8.748889	4.97096
9 =	354.3300	29.52750	9.842500	5.59233

CAPACITY.

	Millilitres or cubic centilitres to fluid drams.	Centilitres to fluid ounces.	Litres to quarts.	Dekalitres to gallons.	Hektolitres to bushels.
1 =	0.27	0.338	1.0567	2.6417	2.8375
2 =	0.54	0.676	2.1134	5.2834	5.6750
3 =	0.81	1.014	3.1700	7.9251	8.5125
4 =	1.08	1.352	4.2267	10.5668	11.3500
5 =	1.35	1.691	5.2834	13.2085	14.1875
6 =	1.62	2.029	6.3401	15.8502	17.0250
7 =	1.89	2.368	7.3968	18.4919	19.8625
8 =	2.16	2.706	8.4534	21.1336	22.7000
9 =	2.43	3.043	9.5101	23.7753	25.5375

SQUARE.

	Square centimetres to square inches.	Square metres to square feet.	Square metres to square yards.	Hectares to acres.
1 =	0.1550	10.764	1.196	2.471
2 =	0.3100	21.528	2.392	4.942
3 =	0.4650	32.292	3.588	7.413
4 =	0.6200	43.055	4.784	9.884
5 =	0.7750	53.819	5.980	12.355
6 =	0.9300	64.583	7.176	14.826
7 =	1.0850	75.347	8.372	17.297
8 =	1.2400	86.111	9.568	19.768
9 =	1.3950	96.874	10.764	22.239

WEIGHT.

	Milli-grammes to grains.	Kilo-grammes to grains.	Hecto-grammes (100 grammes) to ounces av.	Kilogrammes to pounds avoirdupois.
1 =	0.01543	15432.36	3.5274	2.20462
2 =	0.03086	30864.71	7.0548	4.40924
3 =	0.04630	46297.07	10.5822	6.61386
4 =	0.06173	61729.43	14.1096	8.81849
5 =	0.07716	77161.78	17.6370	11.02311
6 =	0.09259	92594.14	21.1644	13.22773
7 =	0.10803	108026.49	24.6918	15.43235
8 =	0.12346	123458.85	28.2192	17.63697
9 =	0.13889	138891.21	31.7466	19.84159

CUBIC.

	Cubic centimetres to cubic inches.	Cubic decimetres to cubic inches.	Cubic metres to cubic feet.	Cubic metres to cubic yards.
1 =	0.0610	61.023	35.314	1.308
2 =	0.1220	122.047	70.629	2.616
3 =	0.1831	183.070	105.943	3.924
4 =	0.2441	244.093	141.258	5.232
5 =	0.3051	305.117	176.572	6.540
6 =	0.3661	366.140	211.887	7.848
7 =	0.4272	427.163	247.201	9.156
8 =	0.4882	488.187	282.516	10.464
9 =	0.5492	549.210	317.830	11.771

WEIGHT—(CONTINUED).

	Quintals to pounds av.	Milliers or tonnes to pounds av.	Grammes to ounces, Troy.
1 =	220.46	2204.6	0.03215
2 =	440.92	4409.2	0.06430
3 =	661.38	6613.8	0.09645
4 =	881.84	8818.4	0.12860
5 =	1102.30	11023.0	0.16075
6 =	1322.76	13227.6	0.19290
7 =	1543.22	15432.2	0.22505
8 =	1763.68	17636.8	0.25721
9 =	1984.14	19841.4	0.28936

By the concurrent action of the principal governments of the world an International Bureau of Weights and Measures has been established near Paris. Under the direction of the International Committee, two ingots were cast of pure platinum-iridium in the proportion of 9 parts of the former to 1 of the latter metal. From one of these a certain number of kilogrammes were prepared, from the other a definite number of meter bars. These standards of weight and length were intercompared, without preference, and certain ones were selected as international prototype standards. The others were distributed by lot to the different governments, and are called national prototype standards. Those apportioned to the United States are in the keeping of this office.

The metric system was legalized in the United States in 1866.

The international standard meter is derived from the meter des archives, and its length is defined by the distance between two lines at 0° Centigrade, on a platinum-iridium bar deposited at the International Bureau of Weights and Measures.

The international standard kilogramme is a mass of platinum-iridium deposited at the same place, and its weight in vacuo is the same as that of the kilogramme des archives.

The liter is equal to a cubic decimeter of water, and it is measured by the quantity of distilled water which, at its maximum density, will counterpoise the standard kilogramme in a vacuum, the volume of such a quantity of water being, as nearly as has been ascertained, equal to a cubic decimeter.

The office of Weights and Measures, Washington, is the repository of the United States standards, comprising those based on the English system, called customary, as well as those representing the metric system of weights and measures. It has recently received from Paris the national meter and kilogramme prototypes—standards of such unrivaled perfection (excepting, of course, by their fellows) that a brief account of the circumstances attending their construction will prove of interest.

The necessity of having a common standard of length and weight led the principal governments of the world to establish by concurrent action an international bureau of weights and measures at Paris for the construction and preservation of standards. A treaty to this effect was signed at Paris in May, 1875. By this treaty the administrative direction of the bureau was put in the hands of eminent scientific men, who are delegated by their respective governments to supervise its operations. After an exhaustive study of the subject, involving experiments and delay, the theoretical requirements were agreed upon, and the bureau entered upon their practical execution. This in turn involved many investigations in regard to the best methods to be pursued, the improvement and construction of apparatus, and studies in thermometry and barometry, which resulted in establishing a standard thermometric scale and a standard barometer.

It was decided to make the new international meter a line measure, and to derive it and the kilogramme from the meter and kilogramme of the archives. The material chosen for the new standards was an alloy of pure platinum-iridium, in the proportion of nine parts of the former to one of the latter. Two ingots were cast, and from one of them a certain number of kilogrammes were prepared; from the other a definite number of meter bars. The standards of length and weight were intercompared without preference, and certain ones were selected for deposit and safe keeping at the international bureau, and are called international prototypes. The others were distributed by lot to the different governments ordering them, and are called national prototypes.

The distribution was made in September, 1889, and those apportioned to the United States are in the keeping of this office.

The comparison of length measures with the United States standards will be undertaken on application. It is not necessary to explain the well-known methods by which the shorter length measures are compared with greater or less precision. The degree of refinement to which the comparisons are carried will depend, of course, on the purpose for which the measures are to be used; where great accuracy is required, a special understanding with this office should be had. The means used for verifying tape lines are less well known, and a description will therefore be of use.

The United States Mural or Bench Standard.—This apparatus derives its name from the fact that it was originally attached to a wall. As constructed in 1884, and as now arranged, it consists of a wooden bench 104 feet long, having upon it an iron bar with German silver plugs, on which the graduation is traced. The bench is made of white pine wood, well seasoned and painted. The planks used in its construction are 2 in. thick and 11½ inches wide; they are supported on cedar posts firmly planted in the ground.

The top of the bench and the bar are protected from the weather by a cover made in sections, each section attached by hinges to the bench, and sufficiently inclined to shed the rain.

The iron bar offers a continuous surface a little over 100 feet long. The bar is 2 in. wide and $\frac{1}{4}$ in. thick; it rests upon equidistant brass rollers $\frac{3}{8}$ in. in diameter; these in turn rest on the bench.

At each side of the bar, parallel to it and firmly attached to the bench, is a strip of wood of such thickness as to bring its surface even with the surface of the bar. Sufficient space is left between these strips and the bar to allow free circulation of the air and not to hinder the expansion of the bar. At one end the bar has a device for clamping a tape or wire when the initial lines of the latter and of the standard bar are in coincidence. A spring balance for giving any desired tension is also provided. This has a clamp for holding the tape or wire, and it can be set on any part of the standard to conform to the length of the tape. Lengthwise the bar, two parallel series of German silver plugs are inserted in the bar at suitable distances apart to receive the graduation, one being subdivided into yards and in places into feet, the other into meters. The yard graduation is intended to be standard at 62° Fahrenheit, 16·67° Centigrade; the metric at 32° Fahrenheit, or 0° Centigrade.

In comparing, the tape line is stretched under the desired tension on the standard bar, and the difference between its graduation and that of the latter is read either by means of a finely subdivided scale or, where the graduation of the tape warrants the refinement, by means of a low power microscope.

The chief advantage of using an iron bar over marks on bolts let into a wall is that the difference between the expansion of the tape and of the bar is very small.

The question of temperature enters only very slightly, assuming that the temperature at which the iron bar is standard has been carefully determined, and that both tape and bar are at the same temperature during the comparison.

The verification of weights and capacity measures will be undertaken, and a statement issued showing their relation to the United States standards. Weights and measures submitted for comparison should conform to correct principles of construction. The cost of all comparisons for other than state or national purposes must be borne by those for whom they are made. The amount is calculated so as to cover the cost to the general government of the services of the person charged with making comparisons.

SYNTHESIS OF INDIGO.

A new and very simple method of synthesizing indigo has been discovered by Dr. Flimm, of Darmstadt (*Ber. deut. chem. Ges.*, No. 1, 1890, p. 57). In studying the action of caustic alkalies the monobromine derivative of acetanilide, $C_6H_5.NH.CO.CH_2Br$, a solid melting at 131·5°, it was found that when this substance was fused with caustic potash a product was obtained

which at once gave an indigo blue color on the addition of water, and quite a considerable quantity of a blue solid resembling indigo separated out. The best mode of carrying out the operation is described by Dr. Flimm as follows: The monobromacetanilide is carefully mixed with dry caustic potash in a mortar, and the mixture introduced into a retort and heated rapidly until a homogeneous reddish brown melt is obtained. This is subsequently dissolved in water, and a little ammonia or ammonium chloride solution added, when the liquid immediately becomes colored green, which color rapidly changes into a dark blue, and in a short time the blue coloring matter is for the most part deposited upon the bottom of the vessel in which the operation is performed. The fused mass may also conveniently be dissolved in dilute hydrochloric acid, and a little ferric chloride added, when the formation of indigo takes place immediately. The collected blue coloring matter may be readily obtained pure by washing first with dilute hydrochloric acid and afterward with alcohol. That this blue substance was really common indigo was proved by the fact that it yielded several of the most characteristic reactions of indigotin, such as solubility in aniline, paraffin, and chloroform, its sublimation, and the formation of sulphonic acids, which gave similar changes of color with nitric acid to those of indigotin. The final proof was afforded by its reduction to indigo white and re-oxidation to indigo blue by exposure to air. Moreover, the absorption spectrum of the coloring matter was found to be identical with the well known absorption spectrum of indigo. Hence there can be no doubt that indigo is really formed by this very simple process. The chemical changes occurring in the reaction are considered by Dr. Flimm to be the following: Indigo blue is not produced directly, but first, as a condensation product of the monobromacetanilide, indoxyl is formed,

$$C_6H_4\begin{matrix}\diagup NH \diagdown \\ \diagdown COH \diagup\!\!\!\diagup\end{matrix}CH,$$

or more probably a pseudo-indoxyl of the isomeric constitution

$$C_6H_4\begin{matrix}\diagup NH \diagdown \\ \diagdown CO \diagup\end{matrix}CH_2.$$

This intermediate substance then passes over by oxidation into indigo,

$$C_6H_4\begin{matrix}\diagup NH \diagdown \\ \diagdown CO \diagup\end{matrix}C{=}C\begin{matrix}\diagup NH \diagdown \\ \diagdown CO \diagup\end{matrix}C_6H_4$$

two molecules each losing two atoms of hydrogen by oxidation, and then condensing to form indigo. It was not found possible to isolate the intermediate pseudo-indoxyl, owing to its extreme instability; indeed, the all-important point to be observed in the practical carrying out of the synthesis by this method is that the fusion must be performed quickly and the temperature raised rapidly to a considerable height, the whole process occupying only a few minutes. The yield of pure indigo under the conditions yet investigated is not very large, amounting to about four per cent. of the weight of the original anilide.—*Nature.*

WOOL WASTES AS MANURES.

THE waste from the woolen industries is generally rich in nitrogen, and sometimes in potash. Crude wool may be looked upon as consisting of two parts: 1, the true wool, containing 17 per cent. nitrogen; 2, the suint, which contains up to 33 per cent. of potash salts. It will be understood that the first of these leaves residues which are valuable as fertilizers.

All the waste coming from wool, comprising rags, dust from the combing and sifting the sweepings of the rooms, waste from the washing, etc., contains nitrogen in the same proportion as other animal debris; the admixture of earthy and inert matter is often sufficient to lower the percentage of nitrogen considerably, and this naturally takes place to the greatest extent with material which is finely divided. When the residues consist chiefly of the fine pile, their richness in nitrogen may amount to 13 per cent. Those which come into the market usually contain about 3–5 per cent. of nitrogen, together with 0·3 and 0·18 per cent. of phosphoric acid, and sell at about the same price as other fertilizers of animal origin. Contracts should never be entered upon without a previous determination of the value of the goods by analysis.

Dust from sifting is usually richer and contains from 4–6 per cent. of nitrogen; by separating the finest parts from the pile by sifting, it is found that the former only contains 2 per cent. of nitrogen, while the coarser portions contain as much as 5 or 6 per cent. These residues are not usually employed directly, since their decomposition in the soil is extremely slow, and it is therefore necessary to submit them to a preparatory process.

WOOL DUST.

The treatment to which the wool is subjected yields as a waste product a very fine powder, called wool dust or velvet powder, which contains:

	Petermann.	Aubin.	Wolff.
Nitrogen	3·00	2·45	5·2
Phosphoric acid	0·85	0·23	1·3
Potash	0·87	0·74	0·3

RESIDUES FROM WASHING.

During the washing of crude wool, a deposit of impurities and dirt is found. A sample of this, containing half its weight of water, was found to contain:

Organic nitrogen	0·50
Phosphoric acid	0·12
Potash	0·28

The chemical treatment of the wool also yields liquids containing small quantities of phosphoric acid and considerably larger amounts of potash. These solutions may be employed for irrigating the land, but as they are acid they must first be neutralized, and this may be done most economically by means of mineral phosphates.

DIRECT APPLICATION AS FERTILIZERS.

In utilizing these various products for agricultural purposes, it is best to submit them to previous treatment, either by allowing them to decompose in heaps, watering them periodically, or mixing them with lime, or making them up with other materials in composts. In this way their fertilizing action is rendered more efficacious, and their decomposition, which would otherwise only proceed very slowly, is considerably accelerated.

INDUSTRIAL TREATMENT.

The wool waste is in some cases boiled for several hours with alkalies, such as carbonate of soda or lime, which break up and dissolve the fabrics; or it may be dissolved in sulphuric or hydrochloric acid. Another process often employed is that of dry distillation. Recently a process has been introduced by which the waste is treated with steam at 150°, and under a pressure of 5–6 atmospheres. After about 7–8 hours of this treatment a solution is obtained which on evaporation yields a brittle brown substance, which has a cinchoidal fracture, and has been called *azoline.* In all these processes a certain amount of ammonia is formed, which ought of course to be collected.

M. Petermann gives the following analytical details:

	Organic Nitrogen.	Nitrogen as Ammonia.
Waste heated in closed vessels	4·18	1·09
Rags treated with steam	7·5–8·5	0·75–1·00
Clippings, with steam	8·52	0·74

—*L'Engrais.*

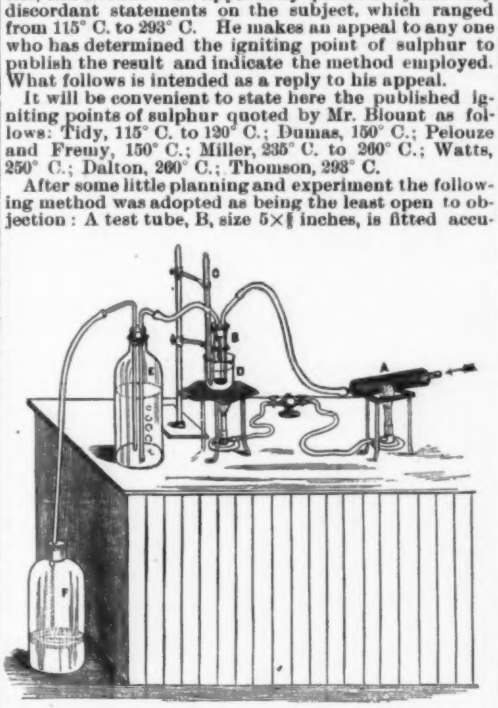
THE IGNITING POINT OF SULPHUR.

By J. RUTHERFORD HILL.

THIS note is the result of some experiments suggested by a letter in the *Chem. News* (vol. lxi., p. 95). Mr. Bertram Blount there states that in the course of a recent conversation a remark was made to the effect that sulphur ignites at a temperature not far above its melting point (107° C.) On referring to published authorities, Mr. Blount was apparently puzzled by the very discordant statements on the subject, which ranged from 115° C. to 293° C. He makes an appeal to any one who has determined the igniting point of sulphur to publish the result and indicate the method employed. What follows is intended as a reply to his appeal.

It will be convenient to state here the published igniting points of sulphur quoted by Mr. Blount as follows: Tidy, 115° C. to 120° C.; Dumas, 150° C.; Pelouze and Fremy, 150° C.; Miller, 235° C. to 260° C.; Watts, 250° C.; Dalton, 260° C.; Thomson, 293° C.

After some little planning and experiment the following method was adopted as being the least open to objection: A test tube, B, size 5×⅝ inches, is fitted accurately with a cork perforated for two glass tubes. The inlet tube, A, passes to about 1 inch from the bottom of the test tube, so as to carry the air down to the surface of the sulphur. The outlet tube, A', stops at the entrance to the test tube; the outlet tube is connected with the aspirator, E, which is emptied by a siphon tube into the receiver, F, and thus draws a current of fresh air through the whole apparatus in the direction indicated by the arrow.



To prevent cooling of the test tube, the fresh air is heated by covering a portion of A with wire gauze and keeping it nearly red hot by a Bunsen flame. By this means it was found that when the current was passing freely, the air entered the test tube at a temperature of about 60° C., and when made to pass slowly, the temperature was considerably higher.

A portion of the sulphur to be tested was placed in the test tube, B. The test tube is immersed, along with a thermometer, C, in a bath of strong sulphuric acid boiling at 332° C. contained in the beaker, D, which is heated by a Bunsen flame. When the thermometer indicates a temperature of about 120° C., the test tube, B, is lowered into the bath, and the air current started by lowering the receiver, F, beneath the level of the aspirator, E.

As the temperature rises, vapor of sulphur, mixed with air, fills the test tube and passes over into the aspirator. There would be risk that when the flashing point is reached, the mass of vapor in the aspirator might also be fired and cause damage. This risk is avoided by causing the outlet tube, A', to pass down to the bottom of the column of water in E, and below the level of the siphon tube. By this means direct communication between the vapor in B and that in E is cut off.

When the thermometer reached 255° C., the vapor of sulphur burst into flame; this occurred several times on repeating the experiment: on one occasion it inflamed at 253° C., and once or twice at slightly higher temperatures. On pinching the India rubber siphon tube with the hand, the air current is stopped, the test tube fills with sulphur vapor, and the flame is instantly extinguished. On removing the pressure from the siphon tube, fresh air immediately enters the test tube and the sulphur vapor instantly rekindles. This takes place with great sharpness, and the operation can be repeated with great ease and rapidity. By removing the Bunsen flame from the bath, D, the temperature rapidly falls, and the sulphur flame can be extinguished and rekindled at every degree. This continues till the thermometer falls to 248° C., but below that temperature the vapor will not reignite. The experiment was repeated eight or nine times with the same result. On one occasion the thermometer was read 246° C. when the flash last appeared, but this was possibly a mistake in observation.

An experiment was now made to ascertain if the sulphur inside the tube was at the same temperature as that indicated by the thermometer in the sulphuric acid bath outside. A thermometer was placed in a test tube containing sulphur. This test tube was placed in the sulphuric acid bath. On applying heat it was found that while the temperature was rising, the sulphur inside the test tube was always at few degrees lower temperature than the sulphuric acid outside. On withdrawing the heat and allowing the temperature to fall, however, it was found that both thermometers speedily indicated the same temperature, and continued to fall at the same rate.

This would indicate that the point at which the sulphur flame was first seen (255° C.) was probably not the real temperature inside the tube, and also that the point at which the flame ceased while the thermometer was falling (248° C.) was the real temperature inside the tube. To test this point the sulphuric acid bath was raised once to 261° C., and at another time to 271° C., and on both occasions the flame disappeared on allowing the temperature to fall to 248° C.

Mr. D. B. Dott has kindly tested my thermometer by a comparison with a standard instrument, and the foregoing temperatures have been corrected accordingly.

From these results it would appear that the igniting point of sulphur in air is 248° C., and that the temperature stated by Watts (250° C.) is most nearly correct. It may be noted that the sulphur used was sublimed sulphur of ascertained purity and free from moisture.—*Chem. News.*

SEPARATION OF ZINC FROM NICKEL.

By H. ALT and J. SCHULZE.

IN a solution of zinc and nickel containing a sufficiency of succinic acid, a current of sulphureted hydrogen precipitates all the zinc as a perfectly white zinc sulphide, while the nickel remains in solution. The liquid may be either hot or cold, and an excess of the precipitant is not objectionable. The succinic solution must be free from salts, as otherwise nickel sulphide may be simultaneously precipitated.

The authors give an especial description of the analysis of nickel silver. The alloy is dissolved in nitric acid, which is almost entirely driven off by heat, the stannic acid is filtered off, and the copper is precipitated with sulphureted hydrogen. The filtrate is evaporated down to a small volume, the sulphureted hydrogen being expelled. Potassa lye is then added almost to neutrality, and the liquid is precipitated with 10 to 20 drops of a 10 per cent. solution of sodium acetate. The precipitate of basic iron acetate is filtered off, any excess of acetic acid is expelled by boiling the filtrate with an addition of a mineral acid, and the bases are precipitated with sodium carbonate at a boiling heat.

The zinc and nickel carbonates are filtered off, washed, and dissolved in succinic acid, filtered if needful, the liquid made up to a known volume, and an aliquot part of the liquid is taken for further treatment. The authors take from 1·5 to 2 grammes of the alloy, make up the solution to 500 c.c., and take 100 c.c. for further treatment. There are added 5 grammes succinic acid, the liquid is slightly diluted with water, heated almost to a boil, and treated with a current of sulphureted hydrogen until it smells strongly of the gas. It is then let stand for twenty-four hours, filtered, the white zinc sulphide is washed, and determined as such.

The filtrate is mixed with a little hydrochloric acid (to prevent any deposition of nickel sulphide on heating in consequence of the great dilution of the succinic acid), and the hydrosulphuric acid is expelled by evaporation. The liquid is then treated at a boiling heat with potassa lye, when nickelous oxide is precipitated quantitatively even in presence of much succinic acid. —*Berichte der d. Chem. Gesellschaft and Chemiker Zeitung; Chem. News.*

NEW ZINC AND CADMIUM SALTS.

A SERIES of new compounds of hydroxylamine, NH_2OH, with several metallic chlorides, are, says *Nature,* described by M. Crismer in the current number of the *Bulletin de la Societe Chimique.* The first member of the series obtained was the zinc compound $ZnCl_2.2NH_2OH$, whose existence was unexpectedly discovered during the course of experiments upon the action of metallic zinc on aqueous hydroxylamine hydrochloride. A ten per cent. solution of this latter salt was treated with an excess of pure zinc; no evolution of gas was noticed in the cold, but on warming over a water bath a slow disengagement of bubbles was found to occur. After allowing the reaction to complete itself during the course of a few days, the liquid, which had become turbid, was filtered, allowed to cool, and again filtered from a little more flocculent material which separated out, and finally concentrated and allowed to crystallize. A large quantity of hemispherical crystal aggregates then separated, which were found on analysis to consist of the new salt, $ZnCl_2.2NH_2OH$. Several other methods of obtaining it were investigated; it may be obtained by treating an aqueous solution of hydroxylamine hydrochloride, $NH_2OH.HCl$, with zinc oxide or carbonate, or with a mixture of zinc sulphate and barium carbonate, or by treating an alcoholic solution of hydroxylamine with zinc chloride. But the best method, and one which gives 97 per cent. yield, consists in dissolving ten parts of hydroxylamine hydrochloride in 300 c. c. of alcohol in a flask provided with an inverted condenser; the liquid is then heated to the boiling point and five parts of zinc oxide added, the boiling being continued for several minutes afterward. The clear liquid is then decanted and allowed to cool. After the deposition of the first crop of crystals, the mother liquor may be returned to the flask and treated with a further quantity of zinc oxide, four repetitions of this treatment being sufficient to obtain an almost theoretical yield of the salt.

The white crystals are then washed with alcohol and dried in the air. They resist the action of most solvents, water only slightly dissolving them, and that

with decomposition. Organic solvents are practically without action upon them. When heated in a narrow tube as in attempting to determine the melting point, the salt violently explodes. If a quantity is heated to about 120° C. in a flask connected with a couple of U tubes, the second containing a little water, gas is abundantly liberated, and drops of hydroxylamine condense in the first U tube, together with a little nitrous acid. The water in the second tube is found to contain hydroxylamine, ammonia, and nitrous acid, while fused zinc chloride remains behind in the flask. A similar cadmium salt was also obtained, $CdCl_2.2NH_2OH$, in brilliant crystals which separated much more quickly than those of the zinc salt.

This cadmium compound is much more stable under the action of heat, gas being only liberated in the neighborhood of 190°-200°, and only a little hydroxylamine distills over.

The barium salt, $BaCl_2.2NH_2OH$, is a specially beautiful substance, crystallizing from water in large tabular prisms, which are very much more soluble in water than either of the salts above described.

A UNIQUE ARCHÆOLOGICAL RELIC.

INDIAN pipes have long been objects of especial interest to archæologists in America, as they embodied the higher art ideals of the aborigines, and, as more or less associated with sacred uses in Indian ceremonials, they were regarded by their makers with both reverence and affection. We may believe that the same loving pride with which the smoker of to-day cherishes the deepening colors of his oil-imbued meerschaum led these early devotees of the "fragrant weed" to expend their skill upon the preparation of the pipe, and to distinguish it among the more common articles of their households by elaboration and ornament. Many Indian pipes are exceedingly simple, but from the attrition of constant use, probably extended over many generations, have assumed an attractive luster and are prized for their polished and darkened surfaces. Others are much ornamented and, as in the case of the famous mound pipes of Squier and Davis, evince an unusual dexterity in their carving. These latter memorable objects, nearly all now unfortunately in the possession of a foreign museum, have been instrumental in determining many of the faunal surroundings of the early occupants of the Mississippi valley, and in one or two instances apparently reveal a migration of their owners from the seaboard.

The remarkable carvings of the Northwest Indians are familiar and striking examples of pipe art, and the less grotesque series made from the catlinite, the red clay stone of the upper Missouri, are also conspicuous in collections as interesting and instructive evidences of Indian fancy.

It has been the fortune of Mr. A. E. Douglass, of this city, to obtain possession of a pipe of a very unique character, and one upon which the archæologist can fitly bestow his very critical attention. Mr. Douglass has called it a "portrait pipe" in allusion to its conspicuous features, three carved facial masks. It was found in San Salvador, Central America, under circumstances that appear to preclude the intervention of any deception. Mr. Douglass has described and figured this singular archæological relic in the *American Antiquarian*, from which, for the benefit of a larger audience than that excellent journal is likely to reach, we make a few extracts.

Mr. Douglass says that this pipe, made of a dark gray slate, "was exhumed from the old Indian workings of the Flamenco Mines—one of the six historical mines noted as developed by the Indians, prior to the Spanish advent."

The description which follows very accurately describes this interesting find, and, in connection with the excellent figures, conveys completely the expression and detail of this noteworthy object.

The extreme length of the pipe and bowl is four and a quarter inches, the height of the bowl two inches. The stem is cylindrical, seven-eighths of an inch diameter at its junction with the bowl, and gradually diminishing to three-fourths of an inch at the end, where it terminates in a raised rim or bead which increases its diameter to seven-eighths. At this end of the stem is a conical perforation, an inch in depth and one-fourth of an inch wide at the entrance, diminishing to one-eighth of an inch, which is the diameter of the perforation from that point to its intersection with the bowl. The striæ about the interior surface of this cone indicate the use of an ordinary *flint* drill. Midway upon the underside of the stem is carved in relief a kind of scroll, attached at either end of the stem—leaving an open loop in the center, each extremity being turned over and perforated. This appendage is two inches in length, three eighths of an inch in breadth, and one-fourth of an inch in thickness, and may have been designed for a cord or strap for suspension, or for a decoration of feathers, trinkets, or possibly gold ornaments. The sides and under surface of this appendage are finished off with marginal incised lines, running lengthwise along the bulge or projecting loop, and crosswise upon the terminal coils. The interior width of the aperture of the bowl is three-quarters of an inch, the rim about it being an eighth of an inch in thickness. The bowl is smoothly finished within to the depth of an inch, and thence to the bottom shows the grooves and furrows peculiar to Indian workmanship. Within a quarter of an inch from the bottom, a circular drill of that diameter has been used to connect it with the channel through the stem.

The most remarkable characteristic of this pipe is found, however, upon the exterior of the bowl. It presents three faces that may well be considered portraits, so carefully and minutely are the features rendered. In front is a male face of a quiet, placid character, the forehead high and well rounded, the nose slightly aquiline, the lips thin, showing the teeth, the chin small and delicate. The face is full, the eyes rather widely apart, and punctured for pearl or gold. About the ends of the mouth is a faint trace of mustache, a characteristic which, though rare, is still to be observed among certain of the Indian tribes in Central America. This face is flanked on either side by a female face or mask of the same size as that just described. On the one side the face is full and round, the eyes drooping and slightly oblique, the pupils punctured for pearls, the cheek bones high and rather prominent, the lips are parted, showing the teeth, the chin small and delicate, the general expression placid and quiet. Upon the other side the face is less agreeable, and may possibly be the portrait of a very aged person. The projecting eyebrows are more distinctly bowed, the eyes wide open, the pupils distended and wanting the puncture, on either side a deep wrinkle runs from the nostril to the extremity of the mouth, which latter shows both the upper and lower teeth, while the upper set alone is visible in the two other portraits, the lower lip is hardly perceptible, and there is a depression in the chin. It is difficult to judge of the expression of these *female* faces from the fact that the prominent features have been worn so considerably by long-continued service that they are reduced to an almost even surface. When laid down, the pipe has naturally rested upon one or the other of these sides, and the eyebrows, nose, lips, and chin, with the beading upon the stem, have been absolutely flattened, while the face has escaped this attrition by its position; but the imagination may conceive what ages of use the pipe has passed through, to exhibit such a trace of wear upon the otherwise enduring stone.

This pipe is in the cabinet of Mr. Douglass, at the American Museum of Natural History, and will repay the examination of the student and historian.

FILLING FOR OLD NAIL HOLES.—The following method of filling up old nail holes in wood is not only simple, but is said to be effectual. Take fine sawdust and mix into a thick paste with glue, pound it into the hole, and when dry it will make the wood as good as new. One correspondent says he has followed this for 30 years with unvarying success in repairing bellows, which is the most severe test known. Often by frequent attachment of new leather to old bellows frames the wood becomes so perforated that there is no space to drive the nails, and even if there was the remaining holes would allow the air to escape. A treatment with glue and sawdust paste invariably does the work, while lead, putty and other remedies always fail.

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